CONTENT COMPLEXITY OF NUTRITION APPS

BY

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DISSERTATION

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ABSTRACT

App use in nutrition education is increasing with 58% of U.S. mobile phone users downloading health apps and 62% of dietitians recommending diet/physical activity tracking apps. App behavior change techniques include goal setting, self-monitoring, and feedback; however, dietitian involvement in app content development remains uncertain. This projects objectives were: understanding nutrition apps' role in knowledge/behavior change; developing an objective app evaluation method; feasibility testing of app incorporation into a University Extension heart health program; and assessment of app incorporation into dietetics practice.

Objective 1 was met through systematic review using the PICOS statement "for adults without disease, will nutrition apps result in increased knowledge or behavior compared to other education types or compared to baseline?", finding 3 studies, all suggesting apps improve participant engagement.

Objective 2 was met through development, face and content validation, and reliability testing of the App Quality Evaluation (AQEL). An initial AQEL item pool (n=94) was expanded with 22 new app-specific items. Face and content validation resulted in 51 AQEL items. For reliability testing, 25 dietitians used AQEL to evaluate apps (n=15) initially and 3 weeks later. Principal component analysis resulted in 25 items in 5 factors: Behavior Change, Knowledge, App Function, Skill Development, and App Purpose. Construct reliability was good for 4 factors (Cronbach's $\alpha>.8$), as was split-half reliability (Spearman-Brown coefficient>.8). Test-retest reliability (Wilcoxon Signed Rank) showed AQEL did not change over time ($p>.05$) except for Skill Development ($p=.001$). AQEL inter-rater reliability was significant (ICC>.8, $p<01$). Additional items assessed Age and Audience Appropriateness. Construct reliability was good for

all age groups (Cronbach's $\alpha>.8$) except adults (Cronbach's $\alpha=.53$). Inter-rater reliability of all 7 AQEL constructs was ICC $(2,15)=.986$, $p<.001$.

Objective 3 tested feasibility (implementation and demand) of app incorporation into an Extension program for heart disease. A high quality DASH app (tested by AQEL) was found scoring >8/10 for Function, Skill Building, Purpose, and Adults appropriateness. Educators offered the app within a heart class. Program attendance and app adoption were low. High quality apps are available to support nutrition interventions; however, the app addition to an Extension heart health program may not be feasible.

Objective 4 was met through the validation and administration of a survey assessing app use in hypertension management by registered dietitians. While many dietitians recommend app resources to patients with hypertension, most do not have a specific preferred app. When dietitians do list a preferred app, MyFitnessPal, a diet-tracking app is the most commonly used. Many barriers to app use were identified, with age of participants and experience with technology being common barriers to the incorporation of apps into hypertension management identified in both the survey and feasibility trial.

While apps are pervasive, actual usage varies. More research is needed to overcome barriers to app use, and to assess the efficacy of apps for behavior change interventions.

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CHAPTER 1: LITERATURE REVIEW

Breadth of Nutrition Education

Nutrition education has been defined as educational strategies, along with environmental supports, targeting food and nutrition behavior to improve health and wellness.[1] Traditionally, nutrition education takes many forms, such as one-on-one counseling in the clinical setting, and group programs in the community setting.[1] Regardless of the setting, nutrition education targets dietary behavior to improve health outcomes. This requires more than just knowledge of *what* behaviors are efficacious; it demands strategies for *how* to establish those behaviors as lifelong habits.

Nutrition education ultimately targets long-term goals such as reducing risk factors for chronic diseases.[2] However, these long-term goals are achieved through short-term targets, such increasing awareness, knowledge and skills, and medium-term goals incorporating the awareness, knowledge and skills into behavior change.[2] The components of interventions and supportive materials used to assist in meeting these goals vary. One area nutrition education interventions vary is in length and dose of intervention. Longer duration interventions with fewer, more focused objectives have been shown to be more efficacious than shorter interventions.[3] While longer duration improves success, resources are often limited, and lower intensity interventions have also been associated with improved, although more modest outcomes.[4] Brief nutrition interventions, defined as a 1-time intervention, may be effective for short-term changes in behavior, but more research is needed to establish efficacy for long-term behavior change.[5] Brief interventions have been shown to be most effective when incorporating

feedback, personalized recommendations, strategies for skill building and for improving self-belief compared to non-tailored education.[5]

The materials used to support education also vary. Printed materials can reinforce and extend education beyond the initial setting.[1] Demonstration videos and hands on activities may be used to enhance skill development.[1] Diet tracking tools support reaching health goals such as weight loss.[6] In addition to duration and supportive tools, education varies by setting. While traditional nutrition education occurred in person, technology has become a platform for nutrition education interventions. Between 2005 and 2009, literature showed computer-based nutrition education providing personalized feedback based on behavior theory to be a successful strategy.[7] The years between 2010 to 2015 were characterized by a move away from computer-tailored interventions to more of a focus on self-monitoring and increased focus on mobile technoloies.[7] This shift to mobile technologies included the incorporation of mobile apps as a strategy for providing support to those receiving nutrition education.

Apps in Nutrition Education Programs

Mobile health (mHealth) interventions present a unique opportunity to facilitate behavior change by targeting various components of nutrition education including goal setting, self-monitoring, and feedback.[8] Mobile health is defined as the use of mobile devices such as smartphones, tablets and wearable devices for health interventions.[9] The field of mHealth research arose from electronic health interventions (eHealth) with a specific focus on portable technologies.

In recent years, dramatic increases occurred in the availability and usage of smartphones and tablet computers. Tablet computer ownership reached 45% of Americans in 2015.[10]

Smartphone ownership has doubled in America since 2011, with 68% of Americans owning a smartphone in 2015.[10] The increased use of these mobile devices presents unique learning opportunities. Mobile learning has been previously defined in terms of both the devices used as learning platforms and the characteristics of mobile learning.[11] Devices supporting mobile learning vary from personal digital assistants to laptops to smartphones. While the devices vary, the characteristics across devices include personalization, informality, pervasiveness, context-awareness, and portability.[11]

Apps and Behavior Theory

Registered dietitians (RDNs) utilize Medical Nutrition Therapy (MNT) to alter the progression of many chronic diseases.[12] As MNT involves modifying eating behaviors, strategies to support behavior change are integral to the MNT process. Mobile apps have emerged as a tool to support behavior change in the management of chronic diseases, including hypertension (HTN), by incorporating such strategies as diet self-monitoring.[13] While apps related to nutrition education are available, and smartphone ownership is becoming pervasive, effectively utilizing apps to support MNT requires an understanding of the role of apps in behavior change as well as in clinical practice. Using the Social Cognitive Theory (SCT)[14] as a framework, the role of apps in supporting behavior change can be theorized in order to identify features of apps that could be useful to support behavior change. The use of SCT to describe the use of interactive technology as an educational strategy for health promotion was proposed as early as 2004 for children.[14] Social Cognitive Theory describes determinants of behavior in three categories: personal factors, behavioral factors and environmental factors.[1,14] Each of these can be examined in the context of health apps.

Personal factors that play a role in behavior change include outcome expectations, attitudes, and self-efficacy. Self-efficacy is the belief in one's ability to succeed at making a behavior change.[14] While an app may not change a person's attitude about the benefit of a behavior change, it can support self-efficacy and goal setting toward making that change. Perceived self-efficacy influences goal setting behaviors; if a person is more confident of success, more difficult goals will be set.[1] Apps can be used to help set and track dietary goals. Apps provide an advantage to traditional goal setting as a smartphone can be with the person at all times in a discrete manner. A recent study examining features of 234 health apps from credible health organizations showed that 72.6% included a tracker.[15] Another study showed that goal setting and self-monitoring are the most common behavior change techniques incorporated into weight management apps.[8] RDNs can use these trackers to help patients see where they have been successful, thus supporting self-efficacy, while at the same time identifying areas to target future goals for change. While trackers are not limited to diet tracking, preliminary research has shown that using an app to track dietary intake increases adherence to treatment compared to traditional paper and pencil food logs.[16]

Environmental factors supporting behavior change include social norms and access (or lack of access) to resources. Mobile devices have rapidly become the social norm, extending into the healthcare arena as 62% of Americans with smartphones report using their device to find information on a health condition.[17] Smartphones have also been shown to bridge resource gaps. A 2015 survey showed that 70% of blacks, and 50% of those earning less than $30,000 per year, use smartphones.[10] A higher percentage of lower income households also report that their smartphone is their only source of internet access, with 13% of Americans earning less than $30,000 per year compared to 1% of Americans earning $75,000 per year depending on

smartphones for internet access.[17] One recent study compared two diabetes medical practices, one predominately underserved African Americans, the other predominately affluent and white.[18] This study found that while patients at the underserved clinic were significantly less likely to own a computer (p=0.008) or have Internet access (p=0.037), cell phone ownership and app use were comparable to the more affluent patients. Additionally, the underserved population expressed a higher interest in using health apps related to blood pressure (p=0.007), exercise (p=0.019) and medication (p=0.037) compared to the affluent clinic. When attempting to bridge environmental barriers to behavior change, smartphone based apps appear to be both preferred by those with fewer resources and more available than computer based technology based interventions.

Behavioral factors include knowledge, skills, and self-regulation.[1] It is theorized that apps can be used to increase knowledge, although more research is needed to support this.[15] Educational components are built into apps, although at a low rate, with only 35% of mobile health apps from credible sources including general education and 14.5% including education tailored to the user.[15] Apps have been designed to both support skills as well as to provide practice in working towards mastery of a skill. Mastering a skill is one way to improve self-efficacy. Albert Bandura, the author of SCT, has reported that interactive media could support children with diabetes in learning the skills needed to manage meals, blood glucose and even dosage of insulin by making a game of learning.[14] Apps can also relieve some of the burden of learning a new skill. When comparing apps, it has been shown that app features that most positively contribute to an app's user rating have the common theme of providing a strategy for care that is more efficient than traditional methods.[18] These behaviors include helping users learn and interpret steps required to reach a health goal, sharing progress with a provider by sharing

app data, and intuitive usability of the app.[18] When selecting apps for supporting patient care, it is important to select apps that support learning disease management skills while alleviating the burden of traditional methods.

App Content

App features that result in improved clinical outcomes are unknown; however, effective features of in-person counseling which are likely to be effective in apps include self-monitoring, goal setting, and problem solving.[19] A number of studies have examined the behavior theory content utilized within apps. A taxonomy to evaluate the use of various aspects of behavior theory within interventions was developed by Michie and colleagues.[20–22] An analysis of 23 weight-loss apps using aspects of this taxonomy found that of 34 behavior change techniques searched for, the mean number of behavior change techniques used in apps was 10 with a range of 1 to 17.[8] The most common techniques used were self-monitoring, goal setting, and feedback.[8] Self-monitoring of behavior was used in 87% of the apps, 83% utilized self-monitoring of outcomes.[8] In regards to goal setting, 57% included behavioral goal setting, 83% utilized outcome goal setting.[8] Feedback on behavior was incorporated in 70% of the apps, 74% included feedback on outcomes.[8]

Other studies compare app content to behavior strategies utilized in established interventions. One such study assessed 16 iPhone and 13 Android weight loss apps for strategies used within the Diabetes Prevention Program, finding that 93.3% and 90% of apps, respectively, utilized goal setting for weight loss and diet, and 86.7% included calorie tracking with feedback.[23] The rest of the strategies of the Diabetes Prevention Program such as physical

activity goal setting, portion control, and problem solving occurred in 20% or less of the apps.[23] No difference was shown in the use of strategies between paid and unpaid apps.[23]

In addition to variations in number and type of behavior change techniques included in apps, app quality has also been shown to vary.[8] While functionality tends to be high in apps, information quality ratings are often lower.[8]

App Quality Assessment

While apps have been evaluated for their use of behavior change techniques, and attempts have been made to evaluate app quality, a need exists to establish a systematic method of evaluating health apps.[24–26] An investigation into the best practices for evaluating health app quality recommended that apps be evaluated based on 3 domains: usability and functionality, critique of potential to promote behavior change, and quality of health-related content.[27] Of the 36 app evaluation articles in this review, none included all 3 domains. Additionally, only 17 of the studies downloaded the app, and most utilized self-developed lists that lacked validation. While a specific need exists to evaluate the quality of apps in order to ensure highly functional apps with accurate content are used in nutrition education, selecting and evaluating apps remains a complex challenge.[28]

Apps and Hypertension

Chronic diseases, including cardiovascular diseases, diabetes, and cancers as well as contributing factors to these diseases such as weight gain, hypertension (HTN), insulin resistance, and hyperglycemia, have established relationships with foods, nutrients, and dietary patterns.[29] Nutrition education apps are available targeting aspects of chronic diseases.

Hypertension is a particularly attractive target of app-based interventions as there are no daily symptoms, but significant morbidity occurs if the disease is left untreated.[30]

A well-established nutrition treatment for HTN is Dietary Approaches to Stop Hypertension (DASH).[31,32] The DASH eating plans vary based on caloric intake, and include recommendations for the amount of food groups to consume at various caloric levels. At 2100 calories, the DASH feeding diet trials provided 7.7 servings of grains, 5.2 servings of fruits and fruit juices, 4.4 servings of vegetables, 1.6 servings of meat with 0.5 servings from red meat, 0.6 from poultry and 0.5 from fish, 2 servings of low-fat dairy and 0.7 servings of regular dairy, 0.6 servings of nuts, seeds, and legumes, 0.5 servings of sweets, and 2.5 servings of fats, oils, and salad dressings.[33] In addition to food groups, the DASH trials targeted higher levels of fiber, calcium, magnesium, and potassium intake, lower cholesterol, and consistent sodium compared to control. Other nutrient levels were changed in the DASH diet trials beyond those targeted; as a result, the conclusions drawn from the DASH trials are based on a dietary pattern for blood pressure reduction rather than a specific nutrient. This pattern places emphasis on increasing fruits, vegetables, low-fat diary, and fish while decreasing red meat and fat.[33]

With controlled feeding trials of the DASH diet, reduction of blood pressure by 11.4 mmHg systolic and 5.5 mm Hg diastolic was observed after 8 weeks in those with HTN ($p<.001$).[31] Reductions in blood pressure were also observed in normotensive individuals, with mean reductions of 3.5 mm Hg systolic ($p<.001$) and 2.1 mmHg diastolic ($p=.003$).[31] When participants prepare their own meals, the level of adherence to the DASH diet correlates with the magnitude of blood pressure reduction; thus, strategies to improve DASH diet adherence should result in more positive outcomes.[34]

Recent evidence shows that app use in interventions has been associated with improvements in weight loss outcomes,[35] while research connecting apps to other improvements in clinical outcomes for chronic disease is limited. Preliminary research on apps targeting diabetes self-management shows promise for improvement of clinical outcomes; however, more rigorous research is needed before conclusions can be made.[36] In a meta-analysis of Internet-based interventions targeting blood pressure reduction, the effect size translated to a decrease of 3.8mm Hg systolic blood pressure (95%CI, -5.63 to -2.06) and -2.1 mmHg diastolic blood pressure (95% CI, -3.51 to -0.65).[37] This same study, found that the most successful interventions provided information on behavioral consequences (86%), provided performance feedback (86%), utilized self-monitoring of behaviors (71%), and provided instructions on how to perform behavior change (71%).[37]

While mHealth interventions in general show promise for improving blood pressure control, research specifically targeting the efficacy of apps for blood pressure reduction is limited.[19] A study of an app for assessing heart health risk and providing strategies for risk management from the Heart and Stroke Foundation of Canada assessed user engagement (n=574,330).[38] Analysis of a subset of the study (n=52,431) found that while younger people were more likely to download an app, older participants (≥51 years) were more likely to engage in the app's challenges ($p<.001$). Other factors that predicted engagement in challenges were sex, ethnicity, cardiovascular disease risk factors, and family history of heart disease. However, completion of nutrition challenges was the lower than other types of challenges with 8.82% of nutrition challenges completed compared to 50.39% of alcohol related challenges.

Another paper looking at the characteristics of HTN apps available as of May 2014 identified 57 apps from the Apple App Store and 50 apps in Google Play.[39] Of the 107 apps,

71.9% allowed for tracking related to HTN management. When examining specific tracking features available, 2.8% of apps allowed tracking of salt, 4.6% tracking of calories, 27.1% tracking of weight or BMI, 69.1% tracking of blood pressure, and 61.7% tracking of heart rate. General information on HTN management was provided by 37% of the apps studied, and 8.4% included information on the DASH diet. Only 2.8% of the apps had an affiliation with a health care agency or professional organization, and 65.4% of the apps were free.

A prototype DASH diet app has been described, which includes tracking and feedback for weight, physical activity, blood pressure and DASH diet.[40] The prototype also includes both synchronous and asynchronous mHealth coaching incorporating motivational interviewing. While this app is not yet available, the project highlights the need to incorporate behavior change theory into app use, to break away from traditional methods when creating behavior change tools in an mHealth environment, and to involve multiple disciplines in development.

A review of mHealth interventions to provide behavioral interventions for cardiovascular disease risk factors of smoking, low physical activity and unhealthy eating emphasized that apps are available for diet tracking and weight management, but did not discuss apps for specific cardiovascular diseases.[41] This study found that apps are available targeting nutrition risk factors of cardiovascular disease, but the impact of these apps on clinical outcomes has not been established.

Conclusion

Apps present a unique strategy to support nutrition education. Due to the variability in content and quality of apps, careful assessment of apps is needed before selecting an app for use in an intervention. Additionally, research is needed to establish the relationship between behavior

change techniques utilized within apps and improvements in adherence to interventions as well as educational and clinical outcomes. In support of this need, the American Heart Association's scientific statement-*Current Science on Consumer Use of Mobile Health for Cardiovascular Disease Prevention* concludes that while apps have the potential to overcome limitations of traditional interventions such as in-person counseling or patient handouts, more rigorous testing is needed to establish if these apps can improve behavioral and health outcomes, and to establish best practices for incorporating apps into ongoing patient care.[19]

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CHAPTER 2: THE USE OF MOBILE APPS TO IMPROVE NUTRITION OUTCOMES: A SYSTEMATIC LITERATURE REVIEW[1]

Introduction

The aggressive evolution of telemedicine services from desktops to mobile platforms has demonstrated a significant impact on the future of healthcare. Mobile technology now allows consumers to access their clinical records to obtain nutrition and physical activity tips on the go. Consumers can access this information and much more on their mobile devices through self-contained application programs also known as apps. This technology has experienced impressive gains in popularity in recent years. Between May 2011 and January 2014, smartphone ownership by U.S. adults increased from 35% to 58%.[1] Among young adults in the U.S., ownership rates are even higher, where 83% and 74% of those within the 18-29 and 30-49 years old sub-groups, respectively, own a smartphone.[2] Tablet computer usage also increased from a meager 3% in 2010 to 42% in 2014 among adult consumers in the U.S.[1] In addition, people typically develop a strong attachment to their mobile devices, and frequently keep this technology with them at all times, a potential benefit in engaging consumers with health interventions.[3]

Mobile platforms could be used as a critical source of information and motivation for behavioral change. This strategy is particularly suited for nutrition interventions, where the consumer is faced with nutrition and diet questions and decisions throughout the day. Indeed, the

[1]**DiFilippo KN, Huang WH, Andrade JE, Chapman-Novakofski KM, The Use Of Mobile Apps To Improve Nutrition Outcomes: A Systematic Literature Review, Journal of Telemedicine and Telecare, 21(5) pp. 243-253. Copyright © [2015] (The Authors). Reprinted by permission of SAGE Publications.**
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daily presence of and access to mobile devices represents ample opportunities to deliver supporting information at any time and any place; therefore, mobile devices increase the potential to promote healthy nutrition behaviors (i.e., keeping a healthy weight, counting calories, making a nutritious meal); and consumers as much as developers are catching up. A search for Android apps using the term "nutrition" in Google Play, for example, reveals 250 apps related to nutrition.[4]

With the potential and availability of nutrition related mobile apps, research is needed to determine what characteristics make these apps effective in supporting behavioral change or increased knowledge among populations at risk of nutrition associated illnesses such as obesity, diabetes and cardiovascular disease among others. While previous reviews have examined the role of mobile technology in weight loss[5] and in food intake record keeping and analysis,[6,7] to the best of our knowledge, no reviews have solely focused on the role of mobile apps in supporting desired nutrition-related behaviors including behaviors associated with healthy weight loss or weight maintenance, diet self monitoring or goal setting. The objective of this systematic review was to explore whether the use of mobile apps could improve nutrition associated knowledge or behaviors in recently published interventions.

Methodology

Determination of Search Terms

To determine the appropriate search terms, as well as inclusion and exclusion criteria, a preliminary search on nutrition apps was conducted in PubMed and the Cumulative Index to Nursing and Allied Health Literature (CINAHL) prior to developing the research question because the topic of mobile learning in nutrition is relatively new. In the Fall of 2013, one

researcher completed this preliminary search including articles from January 2008 to August 2013, using the following search terms: nutrition applications, nutrition apps, mobile nutrition and e-learning & nutrition. This resulted in:

- 776 titles from PubMed for "nutrition applications," 8 from CINHAL;
- 7 titles from PubMed for "nutrition apps," 5 from CINHAL;
- 229 titles from PubMed for "mobile nutrition," 5 from CINHAL; and
- 8 titles from PubMed for "e-learning & nutrition," 3 from CINHAL.

These titles were reviewed by two researchers to confirm whether or not they referred to nutrition apps. Titles that clearly referred to a different scientific field were excluded; titles that clearly referred to nutrition apps, mobile nutrition education or technology, or nutrition and smartphones were kept for a later abstract review. All titles where this distinction was unclear were also kept for abstract review. Abstracts were retained if they pertained to nutrition apps. The keywords of these articles were used to compile a list of potential search terms to be utilized for a formal literature review. These search terms are listed in Table 2.1.

The preliminary search resulted in the selection of the following search terms related to apps: app(s), application(s), cellular phone, iPads, mobile phone, mobile telephone, smart phone and mobile. An additional researcher reviewed the keywords and suggested also using: e-learning, mobility of learning and mHealth. It was determined that: diet, food and nutrition would be qualifiers utilized with each of the terms to isolate nutrition related studies.

Table 2.1. Key words of articles from preliminary search related to nutrition and mobile apps with identification of potential search terms.

Search Term	Nutrition Terms	App Terms
App		X
Behavior Change		
Cellular Phone		X
Diet	X	
Diet-Related Behavior Change	X	
Dietary Assessment	X	
Disease Management		
e-Health		X
Epidemiological Studies		
Everyday Health Technology		
Food	X	
Food Diary	X	
Food Intake	X	
Food Recording	X	
Food Values	X	
Health Applications	X	X
Health Behavior	X	
Health Communications	X	
Innovative		
internet		
iPads	X	X
Lifestyle		
Methodology		
Mobile Application		X
Mobile Health		X
Mobile Phone		X
Mobile Telephones		X
Monitoring		
Nutrition	X	X
Nutritional Dietary Methodologies		
Obesity		
Patient Education		
Primary Prevention		
Qualitative Methods		
Randomized Controlled Trial		
Self-Management		
Smartphone		X
Tailoring		
Technology		X
Technology and Health		X
Text Messaging		X
Web Application		X
Web- and Mobile-Based Nutrition Tools	X	X

Research Question Development

Derived from the PICOS (Participants, Interventions, Comparators, Outcomes, Study design) guidelines,[8,9,10] two researchers developed the following research question for this

systematic review: For adults without disease, will the use of nutrition apps result in increased knowledge or improved nutrition behavior as compared to other educational delivery types or compared to participants' baseline knowledge or behavior in the case of pre/post evaluation? Participants were adults without disease to reflect the broad goals of health promotion rather than medical nutrition therapy as might be associated if targeting adults with a chronic disease. Children under 18 were excluded due to the variations in cognitive and physical development through the age span. There were no restrictions on race, ethnicity or gender, again to maintain the broadest target group. The intervention had to include a nutrition app. Educational apps were specifically sought out. As described by Contento[11] nutrition education is considered to be instruction, an intervention to change behavior such as goal setting and self-monitoring, or an environmental or policy change. As such, nutrition education for this review was considered any app that directly taught users or indirectly attempted to change nutrition-related behavior. Studies that evaluated the reliability or feasibility of diet tracking were not included. Either behavior related to healthy eating (primary outcome) or knowledge (secondary outcome) was included as desired outcomes. Other outcomes related to psychosocial mediators of healthy eating behavior such as adherence to dietary monitoring were also noted during the review.

Database Identification

Initially three experts, two in nutrition, one in educational technology recommended searching in PubMed, CINAHL, Web of Science and Google Scholar. Before searching, researchers eliminated Google Scholar due to the lack of precision.[12,13,14]

The review followed PRISMA guidelines for literature reviews by including the four phases of the PRISMA flow diagram: Identification, screening, eligibility, and included papers evaluation.[15]

Search

Two researchers independently searched PubMed, CINAHL, and Web of Science utilizing the identified search terms and qualifiers. Inclusion and exclusion criteria are provided in Table 2.2. In PubMed and CINHAL researchers limited the search to articles published between 1 January 2008 and 31 October 2013 as the iPhone and App store debuted in June 2007.[16] In Web of Science, the researchers limited the search to articles in between years of 2008 and 2014, on 31 January 2014 as the search configuration for this article search database did not allow limiting to months.

Table 2.2. Inclusion & exclusion criteria for papers where abstract or title indicated congruence with research question.

	Inclusion Criteria	**Exclusion Criteria**
Language	Published in English	Not in English
Peer Review	Peer reviewed	Not peer reviewed
Participants	Human study Adults over 18	Animal study Exclusively children under 18 Disease diagnosis
Dates of Publication	PubMed & CINAHL: 1/1/08-10/31/13 Web of Science: 2008-2014 (searched on 1/31/14)	
App Criteria	Apps used to increase nutrition knowledge And/or Apps used to improve nutrition behavior	Studies of web based programs No app used App development App satisfaction App feasibility Text messaging Digital photography
Type of Study	Randomized controlled trials Non-controlled trials Cohort studies Review studies[a] Meta-Analysis[a]	Descriptive studies

[a] Not used in final analysis

Screening

In PubMed and CINAHL, each "term" AND "qualifier" combination was searched, limited to 1 January 2008 through 31 October 2013 and articles published in English. Filters for human research were used in CINAHL, but not in PubMed as applying this filter in PubMed resulted in the elimination of titles meeting the search criteria. CINAHL did not recognize "(s)"; therefore, researchers used both "app" and "apps" in place of "app(s)" and "applications" instead of "application(s)". Article search within Web of Science was completed similar to CINAHL. After completing searches in PubMed and CINAHL, researchers identified the search term "applications" as unproductive, as no unique articles were identified with this term. Consequently, "applications" was removed from the search of Web of Science. Each term and qualifier combination was entered with the following options selected: Database limited to Web of Science; Research areas limited to Nutrition Dietetics, Behavioral Sciences, Science Technology Other Topics, Healthcare Science Services, Computer Science, Medical Informatics, Communication, Telecommunications, and Life Sciences Biomedicine Other Topics.

Two researchers independently read the resulting titles. When titles met the inclusion criteria or were unclear, abstracts were read. The same process was completed for abstracts, retaining abstracts that met inclusion criteria or were unclear. Researchers met after completing each database search to compare findings and determine appropriate abstracts for further review. When only one researcher classified an abstract as relevant, the researchers discussed that study until reaching agreement. Finally, articles were read and those that met all inclusion criteria were kept for review.

Articles Included in the Evaluation

For the selected articles, each researcher evaluated the quality of the research as presented using the guidelines set forth by the Academy of Nutrition and Dietetics' Evidence Analysis Manual[17] (Table 2.3). Based on these criteria, two researchers assigned each article a quality rating of positive, neutral or negative (+, Ø, or -), discussing their rankings until reaching agreement. The researchers then reviewed each article, noting primary and secondary outcome measures, characteristics of the app used, any behavior theory, participant characteristics, statistical findings and results. Data were extracted for measures of knowledge and behavior change, as well as weight change, noting *p*-values for significance. Retrospectively, the behavior change strategies used by each study were classified based on the main categories of the Behavior Change Technique Taxonomy[18] (Table 2.5).

Results

Identification

The search resulted in 17,032 titles: 12,010 from PubMed, 260 from CINAHL, and 4762 from Web of Science (Figure 2.1).

Screening

In PubMed, 93 titles met the search criteria (Table 2.2). These reduced to six articles meeting the search criteria after screening abstracts, full articles and comparison by two researchers (Figure 2.1).[19,20,21,22,23,24] In CINAHL eight titles met the search criteria (Table 2.2), which reduced to two full articles (Figure 2.1). These two duplicated articles were identified in the PubMed search.[20,22] In Web of Science, 47 titles met the search criteria (Table 2.2). These

reduced to seven full articles (Figure 2.1), of which all but one[25] had been previously identified in the PubMed search.

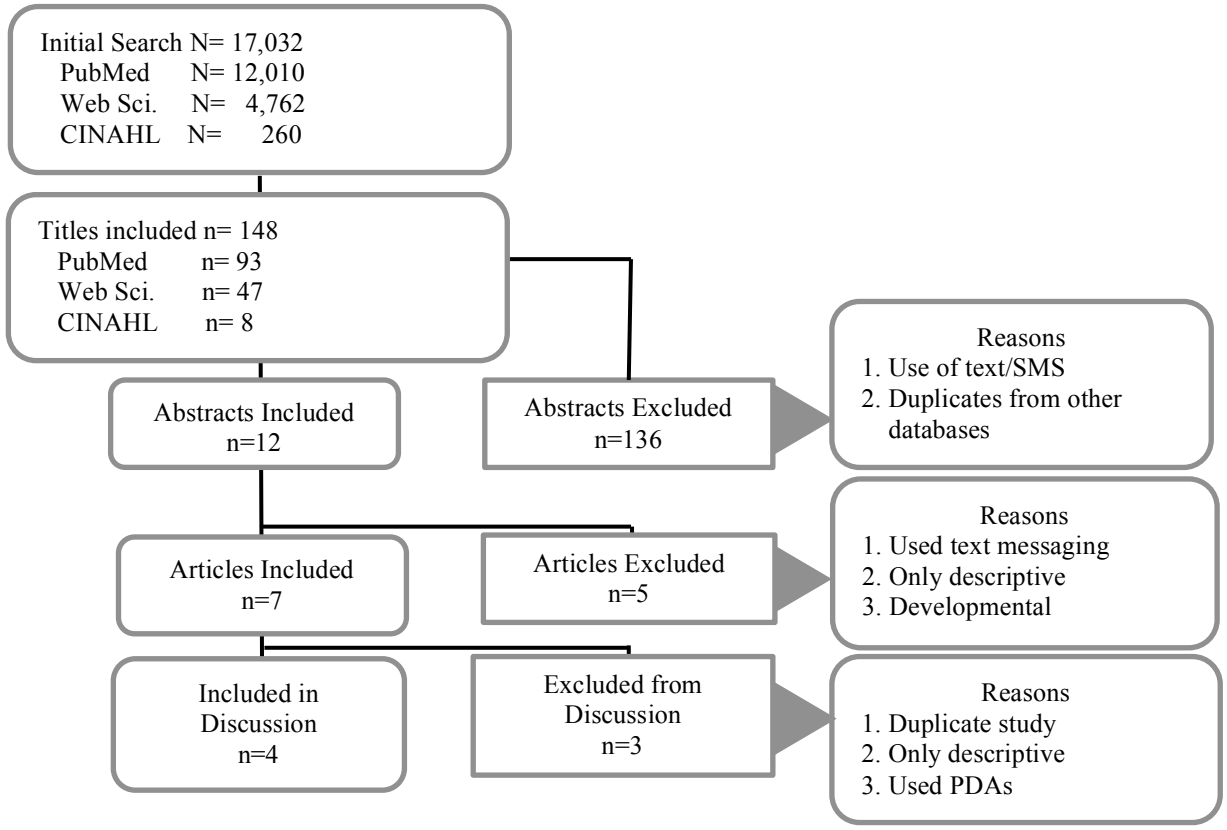

Figure 2.1. Flow chart of search.

Articles included in the evaluation-quality analysis

Two researchers independently read and evaluated the quality of the seven articles using the Quality Criteria Checklist for Primary Research in the Evidence Analysis Manual of the Academy of Nutrition and Dietetics[17] (Table 2.3). This revealed that two of the articles did not meet the inclusion/exclusion criteria outlined in Table 2.2; one studied only Personal Digital Assistants[19] and the other was a descriptive study.[25] The researchers eliminated a third study[20] as a duplicate study.[23]

Table 2.3. Article quality analysis.

				Validity Questions									
Final Quality Rating +,Ø,-	First Author / Location	Title	Evaluator	*Clearly stated research question*	*Subject selection free from bias*	*Comparable study groups*	*Description of method for handling withdraws*	*Blinding to avoid bias*	*Description of intervention/ therapeutic regimens/ exposure factor or procedure, comparisons and intervening factors*	*Clearly defined outcomes, valid and reliable measurements*	*Appropriate statistical analysis*	*Conclusions supported by results, biases and limitations considered*	*Bias due to study's funding or sponsorship unlikely*
+	Brindal 2013 / Australia	Design and pilot results of a mobile phone weight-loss application for women starting a meal replacement programme.	KD	yes	yes	yes	yes	unclear	yes	yes	yes	yes	yes
			KCN	yes	yes	yes	yes	unclear	yes	yes	yes	yes	yes
+	Carter 2013 / UK	Adherence to a smartphone application for weight loss compared to website and paper diary: pilot randomized controlled trial.	KD	yes	yes	yes	yes	na	yes	yes	yes	yes	yes
			KCN	yes	yes	yes	yes	na	yes	yes	yes	yes	yes
+	Turner 2011 / USA	Tweets, Apps, and Pods: Results of the 6-month Mobile Pounds Off Digitally (Mobile POD) randomized weight-loss intervention among adults.	KD	yes	yes	yes	yes	no	yes	yes	yes	yes	yes
			KCN	yes	yes	yes	yes	no	yes	yes	yes	yes	yes
-	Lee 2010 / Korea	Evaluation of a mobile phone-based diet game for weight control.	KD	no	no	no	no	no	unclear	no	no	yes	no
			KCN	no	No	no	no	no	unclear	no	no	yes	no
	Turner 2013 / USA	Comparison of traditional versus mobile app self-monitoring of physical activity and dietary intake among overweight adults participating in an mHealth weight loss program.		Omit-duplicate study to Turner 2011									
	Spring 2012 / USA	Multiple behavior changes in diet and activity: a randomized controlled trial using mobile technology		omit-PDA									
	Kalnikaite 2013 / UK	Decision-making in the aisles: informing, overwhelming or nudging supermarket shoppers?		omit-descriptive									

The researchers completed quality analysis of the four studies independently, then deliberated the results until reaching consensus. Three articles received a positive quality rating.[21,23,24] One article received a negative quality rating eliminating it from further analysis.[22]

Articles included in the evaluation-summary of papers

Study one. Brindal and colleagues' randomized controlled trial piloted an app designed to support weight loss among overweight/obese women enrolled in a partial meal replacement program (Table 2.4).[21] The primary outcomes were weight loss and user engagement. Messages included with the app were designed to target self-regulation and planning, components of the Health Action Process Aproach[26] with the goal of moving participants from pre-intention to behavior change using goal setting and planning.[21] The supportive app group had a higher estimated mean percent weight loss at eight weeks (3.18%, SE=0.38) compared to the control group (2.22%, SE=0.37); however, this was not statistically significant (p=0.08).[21] Brindal also found that when measuring perceived motivation, citing the Theory of Planned Behavior[27] at eight weeks the control group's willingness to stay on the diet decreased compared to those using the intervention app (p=0.024).[21] The support group also reported an increase in positive affect (estimated mean=0.48, SE=0.14) compared to control (estimated mean=-0.01, SE=0.13).[21]

Study two. Carter and colleagues also performed a pilot randomized controlled trial examining the feasibility and acceptability of a weight loss app (Table2.4).[24] While feasibility and acceptability were primary outcomes, anthropometric measures were secondary outcomes that led to the inclusion of this study for review. These anthropometric measures included height, weight and percentage body fat. The app, My Meal Mate, was developed to be similar to MyFitnessPal and Calorie Counter apps.[28] While a specific theory is not mentioned in the study,

self-efficacy is addressed along with the behavioral strategies of goal setting, self-monitoring, and feedback.[24] For comparison, another group utilized a self monitoring website[29] while a third group kept a written food diary using a calorie counting book.[30] The study found statistically significant differences among groups in both participant retention at six months (p=0.001) and usage of the intervention tools at both six weeks (p<0.001) and six months (p=0.001) with results favoring the app intervention.[24] Participants used the app tool more often than the website (p<0.001) or paper diary (p<0.001) groups. In contrast, for the same variable pairwise comparison showed no difference between the website and the paper diary (p=0.14).[24] Weight at six months differed significantly among the groups (p=0.004) and pairwise comparison showed significance between app and website, but not app and paper diary (p=0.12).[24] While a significant difference was not found between the app and paper diary groups, the authors noted that the study lacked power to determine differences in weight loss.[24]

Study three. Turner-McGrievy and Tate reported on a 6 month randomized controlled trial that examined the effect of a Podcast intervention compared to Podcast plus mobile components using FatSecret's Calorie Counter app[31] and Twitter with weight loss as a primary outcome (Table 2.4).[23] The Podcasts were designed based on Social Cognitive Theory.[32] On average, weight changes (SD) were in the order of -2.6%(3.8) and -2.6%(3.5) for women in the Podcast and Podcast+Mobile groups, respectively, at three months, and decreased minimally, -2.7%(5.1) and -2.7%(5.6), respectively, after six months.[23] While most participants did not reach the proposed weight loss (i.e. 5%), the authors noted that the study occurred over the winter holidays in the United States, so weight maintenance during this season may have been beneficial.[23] From the selected articles, this is the only study that included knowledge change; however, the results lacked statistical significance.[23] Other findings included more user control in

Table 2.4. Summary of papers.

	Brindal 2013	Carter 2013	Turner-McGrievy 2011
Primary outcome	Weight loss, user engagement	Feasibility, acceptability, (weight loss-secondary outcome)	Weight loss
Study type	RCT	Pilot RCT	RCT
App used	Meal Replacement Program App	My Meal Mate	Fat Secret's Calorie Counter App Twitter App
App purpose	Provide information, reward positive behavior, diet & weight self monitoring, prompt regular interaction	Goal setting, diet & exercise self monitoring, feedback	Diet and physical activity monitoring Messages from study coordinator and interaction with other study participants
App components	Dashboard: Meal calendar, weight tracker, log of tasks, trophy room, dietary information, message board, customizable settings Prompts: Three daily prompts through Apple Push Notification Service	Weight loss goal setting, daily food diary to target weight loss goal, physical activity diary calculating expenditure, graphs of progress, weekly tailored text messages	Food diary and physical activity diary Messages sent twice daily, study coordinator did not respond, opportunity for participants to interact
Sample	58 women, 19-63 years (mean 42), average weight 92.4 kg (SD=14.7) BMI 26-43 kg/m^2 (mean 34).	128 adults, average age 42 years, BMI greater than 27 kg/m^2	96 adults, 18-60 years, BMI 25 to 45 kg/m^2
Intervention group	Meal Replacement Program: Celebrity Slim two times per day plus one balanced meal Interactive Meal Replacement Program app	My Meal Mate App (similar to MyFitnessPal)	Two podcasts (approximately 15 minutes) per week for 3 months, two minipodcasts (approximately 5 minutes) per week for next 3 months Fat Secret's Calorie Counter app Twitter app
Control group	Meal Replacement Program: Celebrity Slim two times per day plus one balanced meal And App providing information that came with the meal replacements	Weight Loss Resources Website Or Paper food diary, calorie counting book and calculator	Two podcasts (approximately 15 minutes) per week for 3 months, two minipodcasts (approximately 5 minutes) per week for next 3 months And Book with calorie and fat gram information
Study duration	8 weeks	6 months	6 months
Behavior theory	Health Action Process Approach, Theory of Planned Behavior	No specific theory, self-efficacy targeted	Social Cognitive Theory (design of Podcasts)

the Podcast+Mobile group at three months but not at six months *(p*=0.08) and a trend approaching increased elaboration in the Podcast+Mobile group *(p*=0.06).[23] An important consideration of this study was the variable use of apps among participants from both groups. In the group instructed to use an app, only 60% did so; while in the Podcast without app group, 32% of participants did in fact use an app for dietary monitoring.[23] The uneven use of apps could further complicate the analysis of effects on knowledge or behavior variables. When comparing actual app users to non-app users, the authors found that app users kept more consistent daily records, with twice as many days recorded compared to those not using an app.[23]

Retrospectively, the behavioral techniques used in each of the articles were categorized using a previously published taxonomy (Table 2.5).[18] This taxonomy revealed some similarities in the behavior change techniques among the three studies. For instance, all three studies used the feedback and monitoring as well as goals and planning to encourage change. [21,23,24] Two studies used knowledge shaping techniques,[21,23] although one of these used knowledge shaping in another part of the intervention, not directly in the app. [23] A good deal of variability in the behavior change techniques was also present. For example, one study used many additional techniques, including reward and threat, repetition and substitution, associations and identity,[21] while another study added self-belief[24] and the third added social support. [23]

Table 2.5. Taxonomy of behavior change techniques utilized by nutrition interventions involving apps.[18]

	Brindal 2013	Carter 2013	Turner-McGrievy 2011
Scheduled consequences	N/A	N/A	N/A
Reward and threat	Reward system in app "trophy room"	N/A	N/A
Repetition and substitution	Meal Replacement Supplement	N/A	N/A
Antecedents	N/A	N/A	N/A
Associations	Reminders-3 daily prompts through Apple Push Notification Service	N/A	N/A
Covert learning	N/A	N/A	N/A
Natural consequences	N/A	N/A	N/A
Feedback and monitoring	Diet and weight self monitoring	Diet and physical activity self monitoring Feedback on energy intake/expenditure	Diet and physical activity self monitoring
Goals and planning	Same goals for all participants-2 meal replacements and up to 3 snacks daily, weekly feedback on progress	Weight loss goal setting	Goal setting activities with podcasts
Social support	N/A	N/A	Twitter support group
Comparison of behavior	N/A	N/A	N/A
Self-belief	N/A	Messages to increase self efficacy	N/A
Comparison of outcomes	N/A	N/A	N/A
Identity	Self reflection	N/A	N/A
Shaping knowledge	Suggested recipes for meals Snacks defined Meal plan information	N/A	Podcasts
Regulation	N/A	N/A	N/A

N/A-Not applicable, behavior change technique not identified in this study

Discussion

Very few peer-reviewed studies have been published where a nutrition app was used to change dietary behavior or improve nutrition knowledge in adults beyond those apps used for food record keeping only. All three studies evaluated for quality used apps to support user weight loss, along with tools for food record keeping.[21,23,24] Although the quality rating for these studies was good, they were limited in the level of control to clearly dissect the effect of the educational intervention. For example, in one study the apps sent prompts to complete a food diary or record

weight[21] similar to apps without such prompts. In another study, participants kept food records via apps and received motivational feedback in a Twitter group.[23] Overall, there was limited control in the effect of other sources of information or motivation, and thus, both of these only minimally add to passive record keeping as an intervention. Past evidence has shown that the use of diet self-monitoring is an important behavioral strategy for successful weight management.[33,34] A study using a Personal Digital Assistant points to diet-self-monitoring as a significant mediating variable between programed feedback and weight loss.[35] This type of self-monitoring with feedback strategy is similar to that used in apps. Although many apps use tools for client diet self-monitoring, more rigorous research is needed to confirm the effect of app based food records on behavior change.

Goal setting is another feature used in apps. This was a common characteristic in the three studies (Table 2.5). For instance, Carter's study used a behavioral approach, where the app supported goal setting as well as self-monitoring of food intake and activity and feedback.[24] This approach is in line with the goal setting and self-regulation components of Bandura's Social Cognitive Theory.[32,36] A recent systematic review examining goal setting as a component of behavior strategies specific to diet and physical activity in community-based interventions targeting overweight and obese adults showed support for its use in nutrition interventions.[37] The authors also associated goal setting and self-monitoring as components in behavior change.[37] Finally, the authors also cautioned that during interventions different factors are at play (e.g., education sessions, self-monitoring records), and that dissecting the independent sources of effect would be very difficult. These findings in more traditional interventions, while supported by one article in our review,[24] need further exploration when goal setting strategies are facilitated by an app.

Some evidence also showed that apps could be superior in terms of adherence to record keeping compared to paper based methods while maintaining the same level of accuracy.[6,7] Our study sought to look more closely at knowledge and behavior change rather than solely at the use of apps for food records. Nevertheless, the role of apps in supporting adherence or perceived effort to diet monitoring emerged as a theme in all three studies.[21,23,24] Indeed, food journaling through apps may be effective and should be further evaluated in more rigorous studies.

While previous literature has examined technology as a strategy to provide knowledge or promote behavior change, this review adds to that literature by specifically focusing on educational mobile apps in the context of nutrition. One review found that mobile technology supported weight loss in seven randomized controlled trials (four with high bias risk and three with low bias risk), but looked at all forms of mobile technology, not just apps. This same study focused on articles published between 1998 and October 2011, and studies included a range of number of participants per group (19 to 93). Limited sample size, varying lengths and a narrow age range are all included as limitations of the studies reviewed.[5] All studies identified in our review were published after the timeframe of these articles. Another review, which included many forms of mobile technology, examined behavior change in the context of chronic diseases showing mixed results.[38] Articles published between 1990 and September 2010 were included, with the nutrition-related articles being non-app interventions.[38]

Limitations

The small number of available studies, especially randomized controlled trials, limits this review. The use of apps for nutrition education is relatively new, and there is much research to be done. In this study, we sought to explore nutrition education in terms of both knowledge and

behavior change as defined by Contento. [11] The available research focused on behavior, not knowledge. Only one study mentioned knowledge change as a variable, but with non-significant results. [23] Another limitation is that all of the evaluated studies focused on weight loss as a primary outcome. The potential for the use of apps to increase nutrition knowledge and change behavior exists beyond weight loss. In addition, the educational strategies used for comparison should have been better controlled; for example, comparing the additional supporting effect of an app above the use of several other supporting methods such as Twitter, supporting networks, competition-type games, etc. might be very hard to identify with a small sample size and without controlling user time and access. However, due to the limited published evidence found, all articles examining whether apps were effective at all were included within this review.

Implications for Future Research

This review demonstrates the lack of controlled research on the use of mobile technology to increase awareness, cement knowledge and promote change in the field of nutrition. Specific examples for future studies include head-to-head comparisons of app versus non-app interventions delivering similar education, effectiveness of one app versus another; as well as short and long-range behavior changes and additional fidelity to treatment research. A study evaluating current apps on the market found limited use of behavioral theories in apps aimed at targeting behavior change.[39] Interestingly, those studies that designed apps using behavior change theories were ranked lower in popularity.[39] Additional research exploring the incorporation of behavior-change theories, while also considering the components that make apps more popular, is critically needed. Using a standardized taxonomy such as The Behavior Change Technique Taxonomy[18] may also prove beneficial in future studies targeting behavior

change to facilitate comparison between studies. When studying apps, future research should also consider the speed at which technology changes. Strategies to decrease the time from inception to completion such as those described by Riley and colleagues could help the research keep pace with advancements in technology. [40] Significant opportunities exist for future research to explore the potential of apps as a novel way to enhance nutrition knowledge. As app usage becomes increasingly common, the potential for education via this medium needs exploration to optimize outcomes.

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Conflicts of interest

The authors declare that there is no conflict of interest.

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CHAPTER 3: A NEW TOOL FOR NUTRITION APP QUALITY EVALUATION (AQEL): DEVELOPMENT, VALIDATION, AND RELIABILITY TESTING[2]

Introduction

Smartphone ownership reached 68% of Americans in 2015, increasing from 35% in 2011.[1] Smartphones allow instant access to health information, enabling 62% of smartphone owners who obtain information on health conditions via smartphone.[2] A nationwide survey corroborated these results, showing 58% of mobile phone users in the United States had downloaded a health app, citing tracking physical activity (52.8%), tracking diet (46.6%), weight loss (46.8%), and to learn exercises (34.0%) as the most common reasons for health app use.[3] The study further suggested that research is needed to create methods to evaluate health app quality to ensure the needs of app users are met.[3]

Dietitians are using apps in practice; a 2012 survey of Canadian dietitians showed 57.3% of dietitians surveyed used apps in practice, and 83.6% of those not currently using apps expressed interest in future app use in dietetic practice.[4] Whereas nutrition-related health apps are widely available and utilized, health professional's involvement in the development of apps' content and functionalities remains uncertain.[5] Currently, no method grounded in empirical

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[2] DiFilippo KN, Huang W, Chapman-Novakofski KM. A New Tool for Nutrition App Quality Evaluation (AQEL): Development, Validation, and Reliability Testing. JMIR Mhealth Uhealth 2017;5(10):e163. URL: http://mhealth.jmir.org/2017/10/e163/ doi: 10.2196/mhealth.7441

studies for evaluating and selecting apps specifically for use in nutrition interventions exists. When selecting an app for dietetic practice, dietitians resort to subjectively relying on best clinical judgment or relying on similarly subjective recommendations of others.[6]

Standardized app evaluation is called for to present cost-effective, transparent means of providing app developers and distributors with the necessary information to guide app selection.[7] A need for a systematic framework for evaluating health-based apps[8] and weight loss apps[9] have both been emphasized, although a recent investigation into best practices in health app evaluations emphasizes that an available best practice approach could not be identified.[10] The study did identify various constructs evaluated in studies, suggesting that a review of apps should include an evaluation of usability or functionality, a critique of potential to promote behavior change, and the quality of the health-related content.[10] None of the reviewed studies included an evaluation of all three constructs.[10] Whereas studies evaluating nutrition apps have reported the use of evidence-based treatment strategies,[11] the use of theory,[12] as well as behavior change techniques within apps,[11,13-15] a measure of quality as perceived by the health care provider is needed, which evaluates the quality of the content and the functionality of the app to complement previous work evaluating scientific evidence that goes into mobile app development.

With this in mind, the objective of this study was the development, validation, and reliability testing of the app quality evaluation (AQEL) tool, an evaluation instrument for judging the quality of apps to aid in the development and selection of apps for nutrition interventions.

Methods

Survey Development

PubMed was searched first for nutrition and health education apps evaluation studies and

then for educational website evaluation studies to form a pool of initial survey items. Search terms included website, app, and evaluation. The search was not limited by date. No apps evaluation studies were found, but 6 studies were identified that evaluated websites.[13, 16-20] Three studies were excluded after review by 2 researchers. Two of these assessed only for the inclusion of behavior theories rather than broader measures of quality[13,19] and another did not provide specific questions within the paper.[20] The 3 evaluation tools selected to create the initial item pool were chosen based on relevance to education and coverage of items targeting the areas of content, usability, and technology.[16-18]

Ninety-four items from these 3 selected website evaluation tools, with n=43 in one,[16] n=16 in another,[17] and n=35 in the third[18] were entered into a spreadsheet and sorted based on relevance to three categories: content, usability, and technology. One researcher completed the initial sorting of questions, with a second researcher reviewing the category selections. Any disagreement was discussed until agreement was reached. These categories were selected to broadly cover the needs of previously identified stakeholders in nutrition app development and use, namely the researchers and practitioners involved in content selection and distribution of the app as an educational tool,[6] the end users (potential patients or clients) of the app in terms of usability,[6,7] and developers of the app technology.[7] The 2 researchers removed items specific to websites with no relevance to apps, reworded other items to pertain to apps and nutrition, and divided complex questions into 2 or more questions. This resulted in 27 content, 9 technology, and 19 usability items. Additional items were created based on specific features of apps, including transition between pages and touchscreen functionality,[21] with 6 new content items, 8 new technology items, 8 new usability items, and 2 questions identifying the app and the device used to download the app. As the three sources used different rating scales, questions were

converted to 5-point Likert-type scales (content n=26, usability n=19, and technology n=13); yes or no, or yes, maybe, or no (content n=5, usability n=3, and technology n=1); or open ended questions (content n=2, usability n=5, and technology n=1).[15,22]

Content and Face Validation

Nutrition experts and app developers completed content validation by reviewing survey sections; app end users completed face validation. Institutional review board approval was obtained at all points where participants were involved. A total of 13 nutrition experts, including registered dietitians and nutrition professors with publications in app-based nutrition interventions, were contacted to review the 33 nutrition content questions, with 6 agreeing. Of 15 technology experts contacted, 4 agreed. For face validation, app users were recruited through a Web-based weekly email newsletter at the University. This newsletter targets all university employees, not just academic faculty. The first 14 respondents were requested to review the 27 usability questions; 10 completed the review.

Each expert and app user was asked to review the survey selecting from the following options: complete the survey considering an app used in the past, complete the survey reviewing a new app, or provide general opinions of the survey questions. To specifically improve the validity of the survey, experts and app users were asked to cross out inappropriate questions, circle unclear words or phrases, modify unclear questions, add additional questions they felt would improve the survey, and provide any additional comments on survey items they felt would benefit survey development.

After modification based on expert panel review suggestions, further content and face validation was completed because of the magnitude of the changes and to allow review of the

whole tool. Four of six nutrition expert panel reviewers repeated the procedures described above, reviewing all of 51 preliminary AQEL items.

Item Reduction

To reduce and evaluate the reliability of the preliminary AQEL items, nutrition professionals were recruited via an online discussion group from the Nutrition Education for the Public Dietetics Practice Group of the Academy of Nutrition and Dietetics. A total of 25 nutrition professionals evaluated 3 apps each using the 51 AQEL items. These apps were randomly assigned from a pool of 15 apps selected to represent a wide variety of nutrition-related apps, as described later on. This provided 75 evaluations using the preliminary AQEL items. The nutrition professionals completed a second evaluation of each app 3 weeks later, providing a total of 150 evaluations using the 51 preliminary AQEL items.

App selection specifically targeted 3 categories: popular apps, unpopular apps, and app-based games. Popular and unpopular apps were determined by searching the Apple App Store using 6 terms: healthy eating, nutrition, diet, nutrition games, diabetes, and diabetes recipes. This was completed daily (May 2014 to July 2014; January 2015 to February, 2015). In the App Store, the default setting was changed so that the apps were searched *by popularity*, and daily top apps were recorded. Nine apps ranked in the top 3 for their search term in both the 2014 and 2015 searches. Five of these were selected for reliability testing, including a calorie counter, a nutrition quiz, a digestive system game for kids, and 2 diabetes apps. An additional 4 apps were selected that were considered unpopular. Three had fallen in popularity, ranking in the top 6 of the 2014 search but not appearing in the 2015 search. These were a weight loss hypnosis app, a weight loss app, and a calorie tracker. One additional app was considered unpopular as it was the

last English language app listed in a search of nutrition games on June 11, 2015. Six additional apps were selected to increase the number of educational gaming apps because of the specific interest of the research team to better understand educational games.

Item number was reduced first by removing 7 questions where not applicable was selected more than 50% of the time for the 150 evaluations, as the frequent selection of not applicable for a given item indicated that the question was considered by participants as irrelevant for evaluating apps in general. These included questions such as "how well does the app provide capacity to log food?" An additional 10 items were not included in principal component analyses (PCA) that allowed AQEL to be modified for the target audience of the app. Five of these items related to the specific age group the evaluator felt the app targeted, the other 5 to the specific educational needs of the app end user. For these items, the app evaluator selected the groups they would like to evaluate the app for; therefore, limiting the responses to these items.

The 34 remaining items were reduced into categories using PCA with varimax rotation with the 150 app evaluations. Items were removed and analysis rerun when communalities were less than .50. Factor criteria were Eigen values of 1 or more, at least two items per factor, primary loadings of .45 or more,[23] and secondary loadings with a difference of at least .20. Additionally, only the number of factors required to explain just over 70% of the variance were retained. Scree plots were also examined for points of inflection to determine which factors to retain. For further refinement of factors, items not meeting these criteria were eliminated and additional factor analyses were run on the remaining factors with the factor number limited to the number of factors identified in the previous analysis.

Multiple imputation with 100 imputations followed by aggregation of imputations was

used to treat missing data, with new imputations run each time items were removed.

Reliability Analysis

Construct reliability of the final factors was assessed using Cronbach alpha. Spearman-Brown coefficient was used to test split-half reliability. For construct reliability only, items not on a 5-point scale were adjusted to a 5-point scale. These analyses were conducted using the first occasion apps were evaluated. Each rater's first evaluation was used for analysis (n=75). Items within each factor were summed to create factor scores. Test-retest analysis was conducted comparing first and second evaluations using Wilcoxon sign-rank as the data were not normally distributed (n=75).

Interrater reliability (IRR) for the evaluation of each app using factors identified in PCA was tested using one-way random, average measures intra correlations (ICC) using the first evaluation (n=75).

For the items assessing app appropriateness for various age groups (n=5) and target audiences (n=5), construct reliability was measured using Cronbach alpha. For the questions regarding age group, the second evaluation completed by each evaluator was utilized because of a mistake in the questionnaire discovered after many of the first evaluations had been completed. For the target audience, the first evaluation of the app by each evaluator was used. Sample size varied, as evaluators were able to select the age groups and target audiences. All sample sizes are reported.

Further IRR testing of app evaluations using the factors identified in PCA plus the age and audience constructs utilized two-way random, average measures ICC. For this analysis, a new dataset was collected, with 15 nutrition professionals using the AQEL tool to evaluate

MyFitnessPal, the most popular app according to a dietitians' survey (unpublished data, 2017).[24] For this analysis, the age group apps evaluated for was *adults* and the evaluators considered the target audience of *people seeking weight loss support* (n=15).

Reporting on the survey using the Checklist for Reporting of Internet E-Surveys can be found in Multimedia Appendix 1.[25] All statistical analysis were conducted using the Statistical Package for the Social Sciences (SPSS) for Windows, version 24 (IBM Corp).

Results

Content and Face Validation

Specific recommendations from the nutrition experts included clarifying words such as aim and target population, changing the rating scales used, and requesting additional items on skill-building and goals of the apps. App users recommended reducing repetitive questions. Technology experts recommended clarification of 10 items and dividing 3 items into multiple questions plus additional items on data storage and user characteristics. The recommendations of the expert panels led to the modification of nearly every item. Once modifications were completed as described, the three subtools were combined into the full AQEL with 51-scaled items for evaluating app quality plus items for app identification. The second expert panel resulted in minor clarifications.

Item Reduction

For the first round of PCA, Kaiser-Meyer-Olkin measure of sampling adequacy was .59 and the Bartlett test of sphericity was significant (χ^2_{561}=4456, P<.001). Correlations were greater than .30, and communalities were greater than .50 for all items. Nine factors had Eigen values

greater than 1, but 8 factors explained 73% of the variance. When using 9 factors, 3 items were removed because they loaded onto 2 factors with less than a .20 difference; 1 item was removed because it did not load at .45 on any factor. Removing these items resulted in the elimination of a factor; therefore, the next analysis was run with 8 factors.

In the second PCA analysis, Kaiser-Meyer Olkin measure of sampling adequacy was .67, Bartlett test of sphericity was significant (χ^2_{435}=3357, P<.001). The point of inflection on the scree plot indicated that 5 factors should be retained (Figure 3.1); therefore, analysis was rerun with 5 factors. Five items had communalities below .50; these item were removed, and PCA was completed a third time with 5 factors.

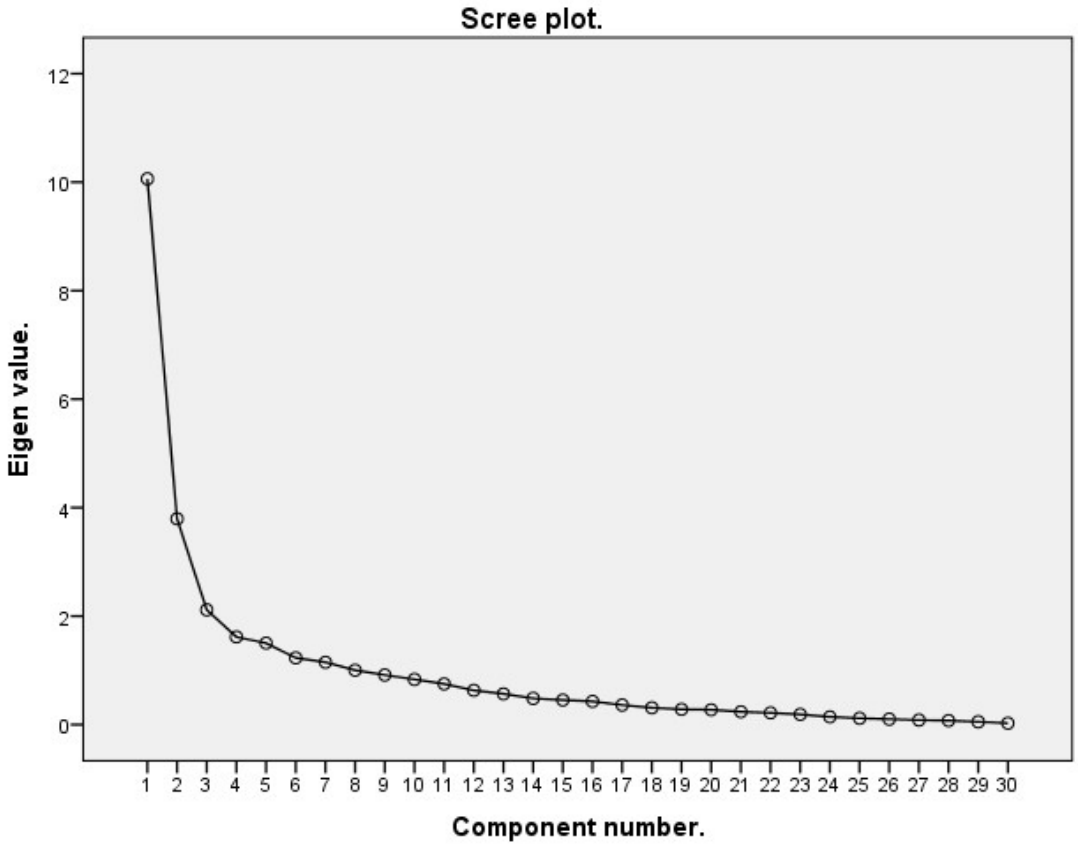

Figure 3.1. Scree plot for second round of principal components analysis of items assessing nutrition app quality.

In the final PCA analysis, Kaiser-Meyer-Olkin measure of sampling adequacy was .81, and Bartlett test of sphericity was significant (χ^2_{300}=2929, P<.001). All correlations were greater than .30, and communalities were .50 or greater when rounded to the nearest tenth. For items that loaded on more than one factor, differences were greater than .20 when rounded to the nearest tenth, and these items were placed on the factor where they loaded the highest. The final factor loadings are presented in Table 3.1.

Table 3.1. Primary factor loadings of items assessing nutrition app quality.

Item	Factor loading value
Factor 1-Behavior change potential	
In your opinion does the app try to change behavior?	.56
Do you think the app will lead to behavior change?	.81
When considering activities within the app, will the activities help the user to change behavior?	.79
Would your friends use this app?	.57
Do you intend to use this app in the future?	.59
Will you do something differently after using this app?	.82
Will you try to do something new after using this app?	.82
Factor 2-Support of knowledge acquisition	
In your opinion, does the app try to increase knowledge?	.78
Do you think the app will increase the user's knowledge?	.69
When considering activities within the app, will the activities help the user to increase knowledge?	.70
How well does the app provide information?	.71
How well does the app provide feedback on progress?	.75
How well does the app provide timely feedback whenever needed?	.77
Is feedback provided when the user participates in an activity in the app?	.67
Factor 3-App function	
Please rate the speed of loading the app	.62
Please rate the user's ability to "retrace their steps" if they need to	.80
Please rate the transitions from page to page	.87
Please rate the function of any animations (quick & functional - slow & fragmented)	.60
Please rate the design of menus and icons	.79
Please rate the ease of navigation to the app's various features	.81
Factor 4-Skill development	
In your opinion does the app try to develop a skill?	.89
Do you think the app will lead to the development of a skill?	.71
When considering activities within the app, will the activities help the user to develop a skill?	.70
Factor 5-App purpose	
Do you feel that the app has a clear purpose?	.68
Does the app title accurately describe the content of the app?	.76

Missing data represented 6.40% (240/3750) of the entries in the dataset. Little missing completely at random (MCAR) test indicated data were not MCAR (χ^2_{1140}=1267, P=.005);

therefore, multiple imputations with 100 imputations were used to treat missing data.

Reliability Analysis

Measures of reliability are reported in Table 3.2. Construct reliability for factors 1 to 4 were all excellent with Cronbach alpha between .80 and .90.[26] Split-half reliability for factors 1 to 4 were also good with Spearman-Brown coefficients between .80 and .90. For factor 5, Cronbach alpha was not used as there were only two items, and split half reliability was .65. Test-retest reliability was not significant, indicating that evaluations of each factor did not change over time, with the exception of the factor evaluating the potential of the app assist skill development (Table 3.3).

IRR for each app was excellent.[27] These results are shown in Table 3.4. The 15th app was not included, as only one evaluator completed the evaluation for this app.

For the 5 items assessing specific age groups, construct reliability was good except for evaluations specific to adults (Table 3.5).[26]

For the 5 items assessing the app's appropriateness of various audience, construct reliability was less than desirable; however, removing one item improved the reliability to be at minimum acceptable (>.70) and for many audiences good (>.80) or excellent (>.90).[19,26] These results are presented in Table 3.6.

In the second dataset with 15 nutrition professionals evaluating My Fitness Pal, two-way random ICC using average measures was excellent, with ICC (2,15)=.99, $P<.001$. Single measure ICC was also good, with ICC (2,15)=.83, $P<.001$, reflecting that the AQEL tool, including both the factors identified by PCA and the two additional modifiable constructs, can be reliably used both by averaging responses of multiple evaluators or by a single evaluator.

Table 3.2. Construct and split-half reliability of factors evaluating app quality (n=75 evaluations).

Factor	Construct reliability (Cronbach alpha)	Split-half reliability (Spearman-Brown coefficient)
Factor 1-Behavior Change Potential	.89	.82
Factor 2-Knowledge	.88	.84
Factor 3-App Function	.89	.83
Factor 4-Skill Development	.81	.83
Factor 5-App Purpose	N/A[a]	.65

[a]Cronbach alpha not applicable as the factor only includes 2 items.

Table 3.3. Test-retest reliability of factors of the App Quality Evaluation (n=75 evaluations).

Factor/Item	Test-retest reliability Wilcoxon Signed Rank test *P*-values
Factor 1-Behavior Change Potential	.13
Factor 2-Knowledge	.05
Factor 3-App Function	.55
Factor 4-Skill Development[a]	.001
Skill Item 1	.01
Skill Item 2	.006
Skill Item 3	.05
Factor 5-App Purpose	.89

[a]Results for individual items shown for Skill Development as differences were found to be significant.

Table 3.4. Inter-rater reliability of dietitians evaluating apps using AQEL (n=75 evaluations).

App	ICC[a](1,k)	*P*-value
Calorie Counter by MyFitnessPal	ICC (1,3)=.88	.003
Nutrition Quiz 600+ Facts, Myths and Diet Tips	ICC (1,3)=.94	<.001
Science Heroes: Digestive System for Kids by Yogome Inc.	ICC (1,5)=.86	.001
Diabetes In Check: Coach, Blood Glucose & Carb Tracer by Everyday Health Inc.	ICC (1,8)=.96	<.001
Diabetes App Lite by BHI Technologies, Inc.	ICC (1,6)=.96	<.001
Weight Loss Hypnosis-Free by Surf City Apps LLC	ICC (1,4)=.80	.01
Jillian Michael's Slim Down	ICC (1,4)=.87	.002
MyPlate Calorie Tracker	ICC (1,5)=.96	<.001
National Center on Health Nutrition Education Gamelettes by ZebraZapps Engineering	ICC (1,5)=.97	<.001
Nutrition and Healthy Eating by Tribal Nova	ICC (1,7)=.95	<.001
Awesome EatsTM by whole Kids Foundation	ICC (1,6)=.95	<.001
Eat Smart by Edin	ICC (1,7)=.92	<.001
Eat & Move O-Matic by Learning Games Lab, NM State University	ICC (1,6)=.96	<.001
Harry's Healthy Garden	ICC (1,5)=.98	<.001

[a]ICC: intraclass correlations.

Table 3.5. Construct reliability of items assessing app appropriateness for evaluator selected age groups.

Age group	Evaluations completed (n)[a]	Construct reliability (Cronbach alpha)
Children	36	.82
Teens	12	.86
Adults	31	.53
General audience	10	.80
Other audience	6	N/A[b]

[a]Analysis of responses from evaluators second evaluation of each app because of survey error discovered during first round of evaluations.
[b]Analysis not completed because of negative covariance among items.

Table 3.6. Construct reliability of items assessing app appropriateness for evaluator-selected audiences.

Audience	Evaluations completed (n)	Construct reliability (Cronbach alpha)	Construct reliability with item 5 deleted[a] (Cronbach alpha)
People seeking help for medical conditions	16	.62	.82
People with specific nutrition concerns	5	.67	.94
People who are shopping for food	3	.40	.98
People seeking recipe/meal ideas	8	.20	.70
People seeking guidance for restaurant eating[b]	1	-	-
People seeking weight loss support	18	.53	.92
People seeking nutrition education	43	.57	.71
Other audience	16	.59	.72

[a]Item 5: Does the level of detail exceed the target populations' abilities?
[b]Analysis not run as only 1 person selected this option.

Discussion

Principal Findings

In summary, the 94 items first selected from the literature were modified to 51 items after expert panel review. Five items evaluating app appropriateness for various age groups and 5 items evaluating app appropriateness for evaluator chosen target audiences were not included in PCA, as the response number to these items was limited. Construct reliability testing of these two constructs resulted in removal of one item evaluating appropriateness for target audiences. This left 41 items to be grouped into factors for evaluating apps. Seven of these were eliminated as raters selected the option of does not apply in more than 50% of the evaluations. Therefore, 34 items were tested using PCA. After three rounds of PCA, the result was a survey with 25 items grouped into 5 factors for evaluating apps, plus 5 additional items that can be used for evaluating app appropriateness for various age groups, and 4 additional items which can be used to evaluate apps for specific target audiences (Multimedia Appendix 2).

The AQEL is a valid, reliable tool for evaluating app quality. Careful consideration of stakeholder needs, including nutrition educators and researchers, app end users, and developers, guided development and assurance of face and content validity. Construct, split-half, test-retest, and IRR were also evaluated to establish the overall reliability of this new tool for use in

evaluating nutrition apps.

The validation and reliability testing of AQEL contributes to the literature by providing a standardized method of evaluating and reporting on nutrition apps, a gap identified previously in app research.[7-10]

Limitations

AQEL allows for the evaluator to specifically choose both an age group and audience for some of the evaluation items. Although a strength of the tool, it did limit the samples size for reliability testing of these items. Addressing characteristics of the intended app user, such as learning preferences and skill with technology, is an important aspect of selecting apps. Generally apps are able to accommodate a wide variety of user preferences as they are able to deliver multimedia content based on users' choices. Rarely do apps only deliver text or multimedia content. Assessment based on age group begins to address variations in app users; however, clinician assessment remains an important piece when selecting apps for clients to account for individual preferences and needs.

App users for face validation were recruited from a population of university employees reflecting a wide range educational experience and income; however, demographic data were not collected from this group.

Rater knowledge of apps is important for completing accurate evaluations. For this reason, raters were asked to spend 10 to 15 min becoming familiar with the app before completing the evaluation.[28] Whereas extensive repeated use of the app would be ideal, this is not always feasible in practice, especially when evaluating a large number of apps. Test-retest reliability showed that for most questions, results remained stable as raters presumably were

more familiar with apps on the second evaluation compared with the first; however, raters were not asked how familiar they were with the app on the first evaluation. Future studies comparing AQEL ratings on first use with later evaluations after regular use of an app would be useful to corroborate this finding.

During validation, a mistake was discovered in the display logic of Q17 to Q21 in the survey. These questions all concerned the subscore of the category appropriateness to the target audience. Of the included 75 surveys 37 had been completed at the time the error was identified. The survey was corrected and updated. To account for this, the analysis of Cronbach alpha for items evaluating app appropriateness for selected age groups were taken from the second evaluation of each app.

Comparison With Prior Work

Previous studies evaluating nutrition apps focus primarily on evidence-based features currently available in apps[11,12] and behavior change techniques or behavior theory use within apps.[11,13-15] AQEL provides the first valid and reliable instrument specifically for dietitians and nutrition researchers to evaluate the quality of apps for use in nutrition interventions. AQEL would add to such evaluations by providing a quantitative method of scoring app quality.

One app selection method in chronic disease management calls for practitioners to create an app library by identifying apps per topic. Evaluation of these apps are based on popularity and incorporation of best practice guidelines, assessing the use of behavior theory using the Behavioral Theory Content Survey,[13] then matching apps to patient preferences and disease etiology.[29] This methodology, inevitably, depends heavily on the popularity rating of an app and requires an individual subjective judgment of the quality of many apps. AQEL could add to this

methodology by proving an objective measure of app quality specific to content for nutrition education.

When evaluating apps in research, it has been recommended to evaluate apps in terms of what works, for which people, and in what circumstances.[6] AQEL allows for this by considering not just the app but also the end user. AQEL is consistent with a previous study evaluating platforms supporting apps, incorporating the same perspectives of developer, end user, and content provider.[30]

At the onset of this study, no tools had been developed for app evaluation. During development of the AQEL tool, another app evaluation tool, the mobile app rating scale (MARS) was published for health app evaluation.[28] This 23-item tool included 5 subscales for measuring app quality: engagement, functionality, aesthetics, information, and app subjective quality. MARS also supplies optional items that can be modified to assess knowledge, attitudes, and intention to change; however, these are not included in the main scoring of MARS. Reliability testing for MARS was completed using evaluation of mental health apps with overall two-way mixed ICC=.79, 95% CI 0.75-0.83, whereas the subscales ICC=.50 to .80. Cronbach alpha of subscales=.80 to .89, median=.85, and overall scale=.90. Although not originally designed for nutrition apps, one recent study used the first four MARS categories to evaluate weight loss apps, finding that IRR between 2 raters was good, with median Krippendorf alpha=.80 and interquartile range=.14.[31]

However, AQEL differs from MARS in several important ways. First, development and reliability testing of AQEL was specifically based on input from practicing and research nutrition professionals. ICC testing in MARS relied on 2 raters' evaluations, whereas reliability testing of the AQEL used 25 raters. PCA was used to refine AQEL, and test-retest reliability was

evaluated; steps not included in the testing of MARS. Second, AQEL includes as primary constructs the categories of behavior change potential, knowledge, and skill development. These categories are not captured as part of the main MARS score; instead, there are optional items assessing similar categories: knowledge, attitudes, and intentions to change. Reliability testing of these categories is not provided for MARS. Behavior change potential, which is included in AQEL but not MARS, along with functionality and the appropriateness and quality of content for the targeted health condition, which are included in both scales, have been cited as critical for a complete evaluation of health-related apps.[10] MARS and AQEL both allow for modification of items concerning the targeted health behavior or audience; only AQEL allows for modification of items based on the targeted age group being considered. This allows greater flexibility as a dietitian could rate the same app differently when considering two different age groups. Finally, AQEL places a clear emphasis on evaluating the ability of the app to support education to increase nutrition knowledge and support behavior change.

An additional checklist was recently published for physician use in evaluating health apps; however, no information is provided on development, validation or reliability testing, and no scoring scheme was provided.[32]

Conclusions

The AQEL is a reliable tool for use when designing educational interventions that include nutrition-related apps. This tool fills a gap by allowing for standardized evaluation of the vast number of apps available for use in dietetics practice and research that have not undergone rigorous testing.[6,9] By providing evaluation based on multiple factors of quality, app selection can focus on the specific needs of the client. For example, if looking for an app specifically to

support behavior change, those scores can be focused on, while also evaluating for functionality and appropriateness for the age and nutrition needs of the client. Scores from the scale can be evidence to justify app selection for interventions as well. Additionally, this tool will help inform app selection in future studies assessing for consistent use, behavior change, and improved clinical outcomes, and to provide dietitians with standardized reports[8-10] on the strengths and weaknesses of apps available to their clients.

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Authors' Contributions

KD was responsible for survey development, participant recruitment, data collection, statistical analysis, and manuscript preparation. WH was responsible for study design, interpretation of results, and manuscript preparation. KCN was responsible for institutional review board's approval, study design, analysis, and manuscript preparation.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Checklist for Reporting Results of Internet E-Surveys (CHERRIES). (Appendix A)

Multimedia Appendix 2

App quality evaluation. (Appendix B)

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CHAPTER 4: MOBILE APPS FOR THE DIETARY APPROACHES TO STOP HYPERTENSION (DASH): APP QUALITY EVALUATION[3]

Introduction

Smartphones are widely used in the U.S. with 77% of U.S. adults owning a smartphone in 2016.[1] Health app use by smartphone owners has been demonstrated with 58% (934/1604) of U.S. mobile phone users reporting that they have downloaded a health app, and 66% (612/934) of these opening their health apps at least once daily.[2] The most common reasons cited for using apps include tracking physical activity and diet.[2] When examining commercially available apps, it has been noted that most nutrition apps focus on weight loss, limiting the use of apps in other practice areas such as chronic disease management.[3] Clinicians have reported using apps in nutrition education to support diabetes and obesity management (62%, n=445).[4] With regard to chronic diseases, hypertension (HTN) has been identified as an attractive target for the use of health apps as there are no symptoms, but morbidity is significant if HTN is left untreated.[5] Research focusing on the use of apps in the management of HTN has been called for,[3] with a specific emphasis on incorporating current knowledge of effective interventions in face-to-face counseling into mobile platforms.[6]

The Dietary Approaches to Stop Hypertension (DASH) has been shown to be an effective plan for reduction of blood pressure[7,8] when properly adhered to.[9] While apps are a viable strategy to improve patient engagement in dietary interventions,[10] a 2013 review of cardiovascular disease apps showed that while many apps were available for cardiovascular disease in general, there was a lack of apps for the management of specific cardiovascular conditions.[11] A 2016 review found only 3 studies out of 175 reviewed related to apps and HTN.[12]

[3] Under review. Journal of Nutrition Education and Behavior.

Additionally, many concerns have been identified in evaluating and selecting apps for use in interventions. App store ratings emphasize downloads and popularity, creating a misleading atmosphere that could encourage attractive apps with poor content quality.[13] These apps are often developed by third party companies with a focus on business needs with little to no input from content experts.[13] Many previous studies that reviewed apps chose not to list the reviewed apps, or reviewed the apps based on the description of the app rather than the experience from using the app.[14] Finally, an emphasis has been placed on the need for a systematic framework for app evaluation for health apps in general,[14–16] and for HTN apps particularly.[13] Specifically, app evaluations should identify the apps being reviewed,[14] provide input from professionals,[16] and include an assessment of apps' usability, potential to promote behavior change, and content quality.[15] In light of the lack of research in HTN and apps, and to move forward with incorporating quality educational content, into highly functional apps, this study aimed to identify the availability and quality of apps for supporting DASH education using the previously validated App Quality Evaluation (AQEL).[17]

Methods

App Identification

The Apple App Store was searched daily between 10/11/2016-11/11/2016 using the search terms "DASH diet," "hypertension diet," and "blood pressure diet" to identify a pool of app titles related to the DASH diet. The top 6 apps identified in the Apple App Store for each search were recorded daily. Additionally, all apps under the search of "DASH diet" were recorded on November 1, 2016, to identify additional DASH diet-related app titles. Apps that did not require a fee to download were retained. In addition, 1 app with a fee of $1.99 to download

was also retained. This app was listed first more often than any other app under "DASH diet." A *post hoc* review of the fee-based apps included all paid apps identified in both the daily searches of the top 6 apps and the 1-day search of all apps under "DASH diet." Fee-based apps whose titles were relevant to the DASH diet were retained. Two researchers then reviewed descriptions of the remaining titles to identify fee-based apps relevant to the DASH diet. Then, the two researchers downloaded the apps. Each app was reviewed for relevance to the DASH diet by each researcher independently, and both researchers agreed on which apps to exclude from further analysis (Figure 4.1). App inclusion criteria were apps that provided information or tracking specific to the DASH diet. Exclusion criteria were apps that were not related to the DASH diet, apps that provided recipes with no additional information, and apps that provided information on a wide variety of diets where DASH was not the focus.

App Evaluation

Five registered dietitians recruited from the Nutrition Education for the Public Dietetics Practice Group evaluated each app using AQEL.[17] The institutional review board at the University of Illinois approved this research as exempt with a waver of documented consent (Appendix I). The AQEL is a previously validated tool for evaluating nutrition app quality using 7 domains. Face and content validation was completed by app users, technology experts and nutrition professionals. Reliability testing involved nutrition professionals evaluating a variety of nutrition apps. The domains in AQEL are behavior change potential, knowledge support, skill development potential, app functionality, and meeting the intended purpose, plus 2 modifiable domains (modification specified) app appropriateness for target age group (adults), and relevance to the target audience (those seeking DASH diet education and support) (Appendix C). Internal

consistency and split-half reliability of all of the first 5 domains except purpose were good (Cronbach's α>.8, Spearman-Brown coefficient >.8). Purpose only included 2 items, so Cronbach's α could not be calculated (Spearman-Brown=.65).[17] Construct reliability was good for assessing app appropriateness for children, teens, and a general audience (Cronbach's α >.8), and was acceptable for assessing app relevance to the target audience (Cronbach's α >.7). [17] Inter-rater reliability was also good for the 5 main domains for all apps evaluated (ICC(1,k)>.8, and for all 7 domains in a later evaluation of 1 weight-loss app for adults (ICC(2,15)=.98, p<.001).[17] For the evaluation of DASH apps, each dietitian evaluated all 5 apps using AQEL, spending 9.4 minutes in AQEL on average .

As each domain did not include an equal number of questions, all sum scores were converted to a 10-point scale for comparison. The average scores for each domain evaluation were calculated for every app. A score of 8 or higher was considered high quality. Two-way random, absolute intra-class correlations using average measures (ICC) were conducted to assess inter-rater reliability (IBM SPSS version 24.0). An ICC greater than 0.6 was considered good agreement, 0.4-.59 was considered fair agreement. [18]

Results

App Identification

The Apps Store searches resulted in the identification of 9 free apps, 5 that consistently ranked in the top 6 over a months time, and 4 that were identified by an exhaustive search of "DASH diet" on 1 day by the researchers. DASH apps were those that incorporated the recommendations of the DASH diet into their content, including providing information on how to follow the DASH diet and tools for tracking intake of DASH diet food groups.

Among the 9 free apps, 6 apps were excluded after 2 researchers reviewed the apps. One only provided recipes, 1 required additional equipment such as a blood pressure cuff and did not specifically include DASH components, another had little DASH content, and 3 included other diets. This left 3 free apps for review. Among them were, 2 informational apps, and 1 goal

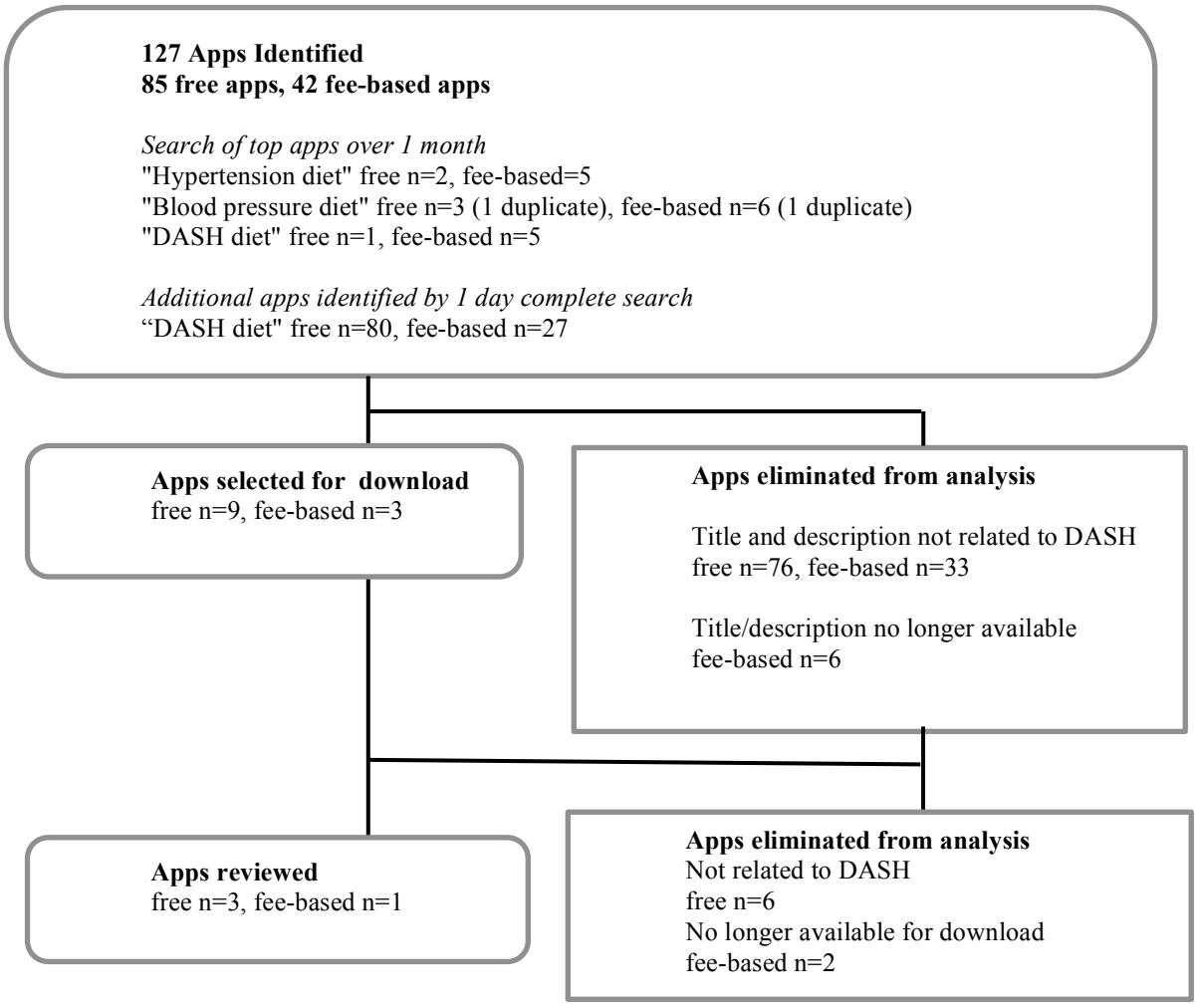

Figure 4.1. Selection of apps for review.

setting and blood pressure tracking app that included suggestions regarding components of the DASH diet (Figure 4.1).

The *post hoc* analysis of the daily searching identified 15 paid apps with titles relevant to DASH. The 1-day exhaustive search identified 27 additional fee-based apps. On review of the 42

paid apps' titles and descriptions, 39 apps were excluded. Reasons for excluding apps were titles unrelated to DASH (n=22), title and description that was no longer available (n=6), promising to cure diseases (n=1), the app description did not match the photo of the app content (n=1), the app only provided recipes (n=4), the app only provided a shopping list or list of approved foods (n=2), the app only provided sodium information for restaurant foods (n=1), the app supplied a collection of articles and e-Book without interactive content (n=1), the app supplied a collection of videos without interactive content (n=1), and the app was about diets for specific blood types (n=1). This left 3 apps that required a fee that were related to the DASH diet. One was the DASH diet-tracking app already evaluated using AQEL. The other 2 were no longer available in the app store.

App Evaluation

The dietitians who evaluated the apps were all female, with an average age of 31.8 (25-42) years old, and had 5.2 (2-12) years' experience in various practice settings. Inter-rater reliability was excellent (ICC>.75) for all but 1 app with fair agreement, with ICC(7,5)=.52, 95% CI .07 to .88 (Table 4.1).[18]

Table 4.1. Inter-rater reliability of app quality evaluations.

	DASH Diet Guide	DASH Diet Food Tracker	Heart BP	DASH Diet for Healthy Weight Loss
ICC(7,5)	.77*	.52**	.78**	.77**
95% CI	.38 - .95	.07 - .88	.40 - .96	.37 - .95

ICC: Two-way random, absolute intra-class correlations using average measures
CI: Confidence Interval
*p = .001, **p < .001

The fee-based app scored high for the following domains on a 10-point scale (AQEL>8): Skill Building, Function, Meeting the Intended Purpose, and Appropriateness for Adults (Table

4.2). For Skill Building, Appropriateness for the DASH Diet, and Behavior Change Potential, AQEL scores were 7.8, 7.3, and 4.8 respectively for the fee-based app. While this was below the previously set cut-point of 8.0, each of these scores was higher than the free apps. In regards to Function, Meeting the Intended Purpose, and Appropriateness for Adults, 1 free app received a high quality score; however, this app received low scores for Appropriateness for DASH, Behavior Change Potential, Knowledge Building, and Skill Development. One free app also received a high quality score for Meeting the Intended Purpose; all other domain scores for this app were low.

Table 4.2. Mean App Quality Evaluation (AQEL) scores out of 10 (n=5).

AQEL Domain	DASH Diet Guide	DASH Diet Food Tracker	Heart BP	DASH Diet for Healthy Weight Loss
Behavior Change Potential	2.9 (1.8)	4.8 (1.4)	4.4 (1.9)	1.3 (1.4)
Knowledge Building	4.2 (1.0)	7.8 (2.2)	6.4 (2.9)	3.8 (1.7)
Skill Building	3.6 (0.9)	8.2 (1.9)	5.6 (3.4)	2.9 (2.0)
Function	6.7 (2.5)	8.1 (2.5)	9.2 (1.3)	6.8 (0.5)
App Purpose	9.0 (1.5)	8.7 (2.2)	8.7 (1.4)	6.3 (2.4)
Appropriate for Adults	7.2 (3.8)	8.0 (3.1)	9.8 (0.5)	6.6 (2.8)
Appropriate for DASH	6.5 (3.9)	7.3 (3.7)	4.0 (4.5)	6.5 (4.2)

Means (SD)

Discussion

The availability of apps supporting DASH education is limited, with only 4 apps identified. None of the free apps available scored well in educational domains (behavior change, knowledge, skill development). The 1 identified fee-based app did score well on 4 AQEL domains, moderately on 2 others, and only scored low for Behavior Change Potential. This indicates that the fee-based app may be useful in supporting DASH skill development in adults.

Previous research has utilized the Mobile App Rating Scale for evaluating health apps, a tool validated using mental health apps.[19] An investigation into the best practices in health app evaluations emphasized that health app evaluations should include 3 domains: usability and functionality, critique of potential to promote behavior change, and the quality of the health related content, and that none of the available methods for app evaluations included all 3.[15] App evaluations using the Mobile App Rating Scale were included in this study, AQEL was not yet available when this study was published. We utilized AQEL as it was developed specifically for use in nutrition apps[17] and included all 3 domains identified as best practice in app evaluations.[15]

Health apps, such as apps for weight management,[20] and medication adherence,[21] have been evaluated for quality in the past . While studies have looked at the availability of hypertension apps,[12] and the availability of heart disease apps in general,[22] this study evaluates the quality of DASH apps. This study also utilizes a systematic framework for evaluating the apps, a previously identified need in health app research.[13,14,16]

Implications for Research and Practice

The quality of free DASH apps as evaluated by AQEL has not been able to support their use with patients. All of the free apps scored low on AQEL in supporting behavior change, knowledge, and skill development. For 2 of the apps that received higher scores for being appropriate for DASH diet education, functionality scores were moderate. This reflects a lack of free apps that function well to support DASH diet education. The fee-based app evaluated could be utilized as a strategy to support DASH diet education. After identifying high quality apps, the final step to evaluating an app is to determine the effectiveness of the app.[15] This app could be used in future studies to evaluate if the use of a high quality app supports sustainable

improvements in clinical outcomes, and if patients are willing to use apps that require a fee when they receive a high quality rating and are recommended by care providers.

This study also suggests that without specific training 3 out of 4 apps were evaluated by dietitians with good agreement, and 1 app with fair agreement. This directly speaks to the value of AQEL, and its readiness for adoption among dietitians as a tool for app evaluation.

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CHAPTER 5: APP USE IN A COMMUNITY BASED PROGRAM FOR HEART DISEASE: A FEASIBILITY TRIAL

Introduction

Hypertension (HTN) impacts 29.1% of U.S. adults age 18 and over, with even higher prevalence with increasing age, impacting 65% of adults age 60 and over.[1] Of adults diagnosed with HTN, only 51.9% have their blood pressure under control.[1] Telehealth presents promise in chronic disease management, especially considering that many suffering from chronic diseases have limited mobility and require frequent clinician visits.[2]

Smartphone and app use in American adults is pervasive with 68% owning a smartphone in 2015, twice as many as in 2011.[3] Smartphone use crosses race, cultural, economic and age lines with 68% of blacks, 52% with incomes below $30,000 per year, 58% age 50-64 years, and 30% age 65+ owning a smartphone.[3] Of those who own smartphones, 61% use their phone to obtain information about health conditions.[4] Health apps are used to measure health metrics, report to physicians, and track various aspects of health.[5] Apps also show potential for cost reduction and overcoming language and cultural barriers. The few pilot studies available indicate that apps increase adherence to dietary interventions; however, few randomized controlled trials have explored outcome measures with regards to app use.[6]

Highly controlled research allows for the determination of causal relationships; however, it fails to address constraints often faced in real life situations.[7] While the impact of the Dietary Approaches to Stop Hypertension (DASH) diet on improving HTN is well established in controlled settings,[8,9] the magnitude of blood pressure reduction depends on the degree of patient adherence to the diet.[10] To reach desired outcomes, interventions with high contact frequency

(more contact with patients during the first 12 months of an intervention) show more potential for effectiveness; however, participation tends to be low.[11] While high contact frequency has been shown to be important for weight loss outcomes, low contact frequency behavior change interventions have been shown to result in diabetes disease risk reduction.[11] Maximizing the potential of low-frequency interventions is important, especially when resources are constrained and a large population is targeted.[11]

The pervasiveness of apps in daily life provides a unique strategy for supporting dietary behavior change interventions.[12] Apps incorporate important strategies for improving dietary adherence to the management of hypertension, such as self-monitoring.[13] Pilot studies suggest app-based strategies may improve adherence to dietary interventions for weight loss; however, more evidence is needed to firmly establish the role of apps as a tool to improve adherence to[6] and targeted outcomes of the DASH diet.[14] The factors that limit adoption and adherence to diet management programs can be evaluated through the use of feasibility studies and the application of technology acceptance and usage theory.

The Unified Theory of Acceptance and Use of Technology (UTAUT) provides constructs predicting behavioral intention to use technology and actual use of technology (Figure 5.1).[15,16] These constructs include performance expectancy, effort expectancy, facilitating conditions, and social influence. Performance expectancy has been defined as "the degree to which an individual believes that using the system will help him or her to attain gains in job performance," effort expectancy as the "degree of ease associated with the use of the system," social influence as "the degree to which an individual perceives that important others believe he or she should use the new system," and facilitating conditions as "the degree to which an individual believes that an

organizational and technical infrastructure exists to support use of the system."[16] Potential moderators of these constructs include age and experience with technology.

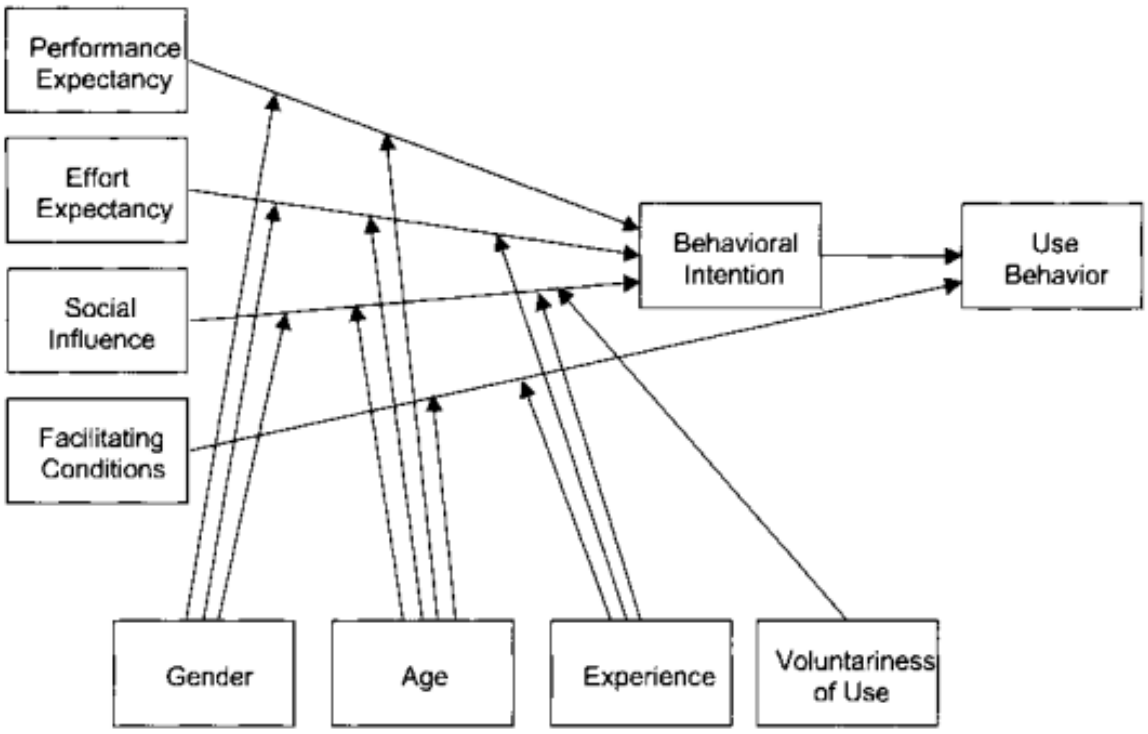

Figure 5.1. Unified Theory of Acceptance and Use of Technology
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This study sought to establish the feasibility, specifically in terms of acceptability, implementation, practicality, and limited-efficacy testing,[7] of incorporating an app into a low contact frequency community-based nutrition program targeting heart disease. The program utilized was Meals for a Healthy Heart (M4HH), an educational program delivered by nutrition educators for University of Illinois Extension across the state. This program incorporates strategies of the DASH diet along with other heart health strategies in 2 sessions lasting approximately 2 1/2 hours each. The objective of this study was to assess the feasibility of

incorporating a high-quality app into the M4HH program both from outcomes evaluation and from the perspective of the educators.

Methods

Intervention

A program titled M4HH: Eating to Lower Your Blood Pressure is offered throughout the State of Illinois by 10 University of Illinois Extension nutrition educators. This program is taught in two sessions, covering many aspects of heart disease with a focus on eating behaviors to lower blood pressure in the first week, including aspects of the DASH diet (Table 5.1).

Table 5.1. Meals for a Healthy Heart program outline.

Week	Topics
1	What is heart disease? Cardiovascular disease risk factors Blood pressure Preventative lifestyle behaviors • Dietary Approaches to Stop Hypertension • Understanding nutrition labels • Physical activity • Goal setting Cooking demonstration
2	Review Cholesterol Dietary fats First-line of treatment • Dietary Approaches to Stop Hypertension (last week) • Therapeutic Lifestyle Change • Mediterranean Diet • USDA recommendations (MyPlate) Second-line of treatment • Cholesterol lowering medications Cooking demonstration Evaluations

The selection of an app for use with M4HH was based on a previous study documenting the quality of apps available for DASH education in the Apple App Store.[17,18] The DASH Diet Tracker was identified as the app with the best quality scores, receiving scores >8/10 for most quality domains. These domains included skill development, functionality, app purpose, and appropriateness of the app for adults. This diet-tracking app individualizes goals for the food groups of the DASH diet and provides a method for calculating and tracking progress toward those goals.

For this study, the educators were contacted and the concept of the study discussed during a team meeting. The educators and Extension administrator were favorable about the study. A Skype meeting was also completed in January with the educators who planned to offer M4HH during February or March 2017 to provide training on study procedures. In order to not disrupt the normal programming efforts, a quasi-experimental design was utilized, where M4HH was offered as planned and study participants were recruited from the program attendees. Participants self-selected to either intervention or control. The intervention was the M4HH program plus education on how to use the DASH Diet Tracker to support the behaviors they had learned in the program. The education was a video of how to download the app and a video of how to use the app shown at the end of the week 1 session of M4HH. The control participants attended the M4HH program, but did not use the app. Each educator could have both intervention and control participants in the same program.

Participants and Study Design

The M4HH educators marketed and recruited for their program in agreement with their normal procedures. Participant recruitment for the app intervention occurred during the M4HH

programs offered in the state of Illinois in February and March 2017. All program attendees were eligible for inclusion. Since the DASH diet has been suggested as an appropriate diet for both management of HTN and for the general public in the Dietary Guidelines for Americans, both normotensive and hypertensive individuals were included.[19] Surveys assessing behavioral outcomes and technology acceptance were collected from M4HH participants at baseline, 1 month, and at 3 months after the program (Appendix D).

All of the educators (N=10) were interviewed regarding the feasibility of the app and M4HH after study completion, including those who had provided the M4HH program, those who had offered the program but it had been cancelled, and those who did not offer the program in February or March of 2017. The educators also completed a survey to assess technology acceptance (Appendix E). These procedures were approved by the Institutional Review Board at the University of Illinois (Appendix I).

Behavioral Outcomes

Treatment and control individuals completed a survey and food frequency questionnaire at baseline, 1 month, and 3 months by mail or online. Variables measured included: DASH diet adherence, knowledge, dietary behaviors, motivation, and self-efficacy. The survey items were from previously validated measures of these constructs, as follows:

DASH Adherence: DASH adherence was measured using DASH-Q, a questionnaire previously validated as part of a larger hypertension self-care assessment.[20]

Knowledge: Items assessing knowledge were from the Hypertension Evaluation of Lifestyle and Management Knowledge Scale (HELM), a scale previously validated in a community-based population of veterans with a mean age of 68.2.[21]

Behavior, motivation, and self-efficacy: Items assessing behavior, motivation and self-efficacy were from the Hypertension Self-care Profile (HBP SCP), validated in an inner-city community through focus groups and by comparison to other measures of HTN non-adherence, medication adherence, and a depressive symptoms.[22]

Items from these tools were reviewed by 2 members of the research team for relevance to program objectives and content. Items were weighted to reflect the number of times the topic assessed by the item was covered in the program, with 1 point for each time a topic was included in a slide, and 0.5 points for each appearance in the lecture notes or handouts. Analysis was completed both without and with weighting. Additional items surveyed included demographics, previous diagnosis of HTN, satisfaction with the program and the app, and previous app use, technology acceptance (see below), and frequency of app use.

All statistical analyses were conducted using SPSS (IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp).[23]

Clinical Outcomes

At the outset of the study, 3 program sites were selected for recruiting participants from both the treatment and control groups for assessment of clinical outcomes at baseline and 3 months including blood pressure, weight, body mass index, and waist circumference. The 3

programs selected for this clinical assessment were all cancelled due to low enrollment. The research team decided to assess other areas of feasibility before scheduling further programs for assessing the feasibility of collecting clinical measures from participants.

Technology Acceptance and Feasibility

Constructs from the UTAUT theory were assessed in participants at baseline, 1 month and 3 months and in the educators after the study was completed using surveys.[16] Data on participant enrollment, device ownership, and agreement to use the app were collected to inform future studies incorporating apps into educational programs for the DASH diet in the community setting.

Additionally, individual interviews were conducted with all University of Illinois Extension educators (N=10) after the completion of the study to assess educator perspectives of the feasibility of incorporating an app into the M4HH program in terms of acceptability, implementation, and practicality (Appendix F).[7] Interviews were selected rather than focus groups to prevent educators from influencing each other's responses. The semi-structured interviews were conducted by telephone (n=10) and were audio-recorded and transcribed verbatim for analysis. Interview duration averaged 24 minutes, ranging from 16 to 46 minutes.

A code book for the interviews was developed using an iterative process by two researchers, including theory-based codes using UTAUT constructs, and structural codes based on the research goal of assessing feasibility.[24] A review of the first round of coding with all transcripts resulted in a revision of the coding schema and codebook. Two researchers then recoded the interviews independently, reaching consensus through discussion where codes differed. Data were analyzed using inductive thematic analysis[25] which enabled the researchers

to evaluate the data and identify concepts and patterns. Because all educators were interviewed, continuing to recruit others until saturation of data was achieved was not possible.

Results

Participants and Educators

Initially, 6 educators scheduled 11 M4HH programs in counties across the state of Illinois for February and March of 2017. Minimum enrollment for the program is 5 participants; 6 of the programs were cancelled due to low enrollment. Consent forms were not completed for 1 program, which was excluded from analysis. This left 4 programs taught by 3 educators for inclusion in the study. The M4HH attendees were all non-Hispanic white, 34 were female, 3 were male and 4 did not report demographic information. Of the 41 M4HH attendees, 25 agreed to participate in the study (61%). Demographics of all Nutrition and Wellness Extension educators in the State of Illinois and of participants in the study are provided in Table 5.2.

Table 5.2. Demographics of Extension Educators and Meals for a Healthy Heart participants.

Characteristics		Educators (N=10)		Participants (n=25)	
Sex					
	Female	10/10	100%	22/25	88%
	Male	-	-	3/25	12%
Age					
	Mean	-	-		61 years
	Median	-	-		66 years
	Range	-	-		27-83 years
Baseline BMI					
	Mean (SD)	-	-		27.6 (6.2)
Baseline BMI					
	Normal	-	-	8/22	36%
	Overweight	-	-	10/22	45%
	Obesity Program I	-	-	1/22	.05%
	Obesity Program II	-	-	1/22	.05%
	Obesity Program III	-	-	2/22	.09%
Ethnicity Identification					
	Hispanic	-	-	-	-
	Non-Hispanic	0/10	100%	20/20	100%
Race Identification					
	Black/African American	1/10	10%	-	-
	White	9/10	90%	20/20	100%
Highest level of education					
	High school	-	-	9/25	36%
	Associate's degree	-	-	6/25	24%
	Bachelor's degree	-	-	9/25	36%
	Master's degree	10/10	100%	1/25	4%
	Registered dietitian	4/10	40%	NA	NA
Self-reported baseline hypertension					
	No diagnosis	-	-	13/25	52%
	Prehypertension	-	-	1/25	4%
	Hypertension	-	-	11/25	44%

Behavioral Outcomes

Survey items addressing behavioral outcomes were assessed using repeated measures ANOVA. Analyses were completed on survey items as originally developed in previously validated surveys, and as scores weighted for the purposes of this study. All non-weighted data met normality assumptions according to the Shapiro-Wilk statistic (p>.05). For the weighted scores, the HELM items, motivation items and the 3-month self-efficacy items from the HBP-

SCP did not meet the assumption of normality. Where the assumption of sphericity was not met, the Greenhouse-Geisser correction was applied. Only those returning surveys at all 3 time points were included in this analysis. This study was not powered to identify differences; however, as limited-efficacy testing was one of the feasibility outcomes, data are shown here to inform future studies (Table 5.3).[7]

Table 5.3. Behavioral outcome mean scores for Meals for a Healthy Heart participants[1] at baseline, 1 month and 3 months with post-hoc comparisons to baseline.

Outcomes Scale range		Mean (SD)	*F*-statistic	*p*-values for post-hoc comparison to baseline with Bonferroni correction
DASH Adherence[2] (n=9) 0-77			$F_{(2,16)}$=1.6, *p*=.23	
	Baseline	42.0 (12.5)		
	1-month	42.2 (15.4)		1.0
	3 months	50.0 (15.9)		.71
Weighted DASH Adherence[2] (n=9) 0-105			$F_{(2,16)}$=.50, *p*=ns	
	Baseline	53.3 (20.1)		
	1-month	54.7 (21.4)		1.0
	3 months	60.3 (24.7)		1.0
Knowledge[3] (n=10) 0-14			$F_{(2,18)}$=2.41, *p*=.12	
	Baseline	7.7 (3.2)		
	1-month	9.0 (2.3)		.46
	3 months	9.0 (2.2)		.19
Weighted Knowledge[3] (n=10) 0-2			$F_{(2,18)}$=1.59, *p*=.23	
	Baseline	1.4 (0.5)		
	1-month	1.8 (0.4)		.31
	3 months	1.6 (0.5)		1.0
Behavior[4] (n=10) 0-60			$F_{(1.2,10.4)}$=3.5, *p*=.09	
	Baseline	33.9 (13.3)		
	1-month	38.7 (11.5)		.33
	3 months	38.2 (11.5)		.09
Weighted Behavior[4] (n=7) 0-85.5			$F_{(2,12)}$=1.1, *p*=.36	
	Baseline	54.2 (20.4)		
	1-month	57.4 (19.6)		1.0
	3 months	61.6 (21.4)		.57
Motivation[4] (n=8) 0-60			$F_{(2,14)}$=1.4, *p*=.28	
	Baseline	43.1 (15.9)		
	1-month	47.3 (12.8)		.57
	3 months	46.0 (12.5)		.33

Table 5.3. Continued.

Outcomes Scale range		Mean (SD)	*F*-statistic	*p*-values for post-hoc comparison to baseline with Bonferroni correction
0-88.5				
	Baseline	72.6 (19.8)		
	1-month	75.8 (15.4)		1.0
	3 months	76.1 (15.1)		.66
Self-efficacy[4] (n=9)			$F_{(1.1,8.4)}$=.76, *p*=ns	
0-60				
	Baseline	55.8 (27.6)		
	1-month	57.2 (26.2)		1.0
	3 months	65.2 (37.2)		1.0
Weighted Self-efficacy[4] (n=8)			$F_{(2,14)}$=.54, *p*=ns	
0-88.5				
	Baseline	67.7 (12.6)		
	1-month	71.0 (16.5)		.97
	3 months	69.6 (18.4)		1.0

[1]Data shown for respondents who returned all 3 surveys. Only non-app users included as no app users returned 3-month surveys.
[2]DASH-Q items
[3]HELM items
[4]HBP-SCP items

DASH adherence was measured with the DASH-Q.[20] Repeated measures ANOVA showed that DASH adherence did not differ over time ($F_{(2,16)}$=1.6, *p*=.23). Similarly, weighted DASH adherence scores did not differ over time ($F_{(2,16)}$=.50, *p*=ns).

Knowledge was measured using HELM.[21] Repeated measures ANOVA found no significant differences in knowledge scores ($F_{(2,18)}$=2.41, *p*=.12) or weighted knowledge scores over time ($F_{(2,18)}$=1.59, *p*=.23).

The HBP SCP was used to assess behavior, motivation and self-efficacy.[22] Repeated measures ANOVA with Greenhouse-Geisser correction showed that behavior did not significantly differ over time ($F_{(1.2,10.4)}$=3.5, *p*=.09). *Post hoc* tests with Bonferroni correction showed an increase in mean behavior scores from baseline (33.9 ± 13.3) to 1 month (38.7 ± 11.5) that was not significant (*p*=.33) and baseline to 3 months (38.2 ± 11.5), that was also not

significant (p=.09). No significant differences were found in repeated measures ANOVA for weighted behavior ($F_{(2,12)}$=1.1, p=.36), motivation ($F_{(2,14)}$=1.4, p=.28), weighted motivation ($F_{(2,12)}$=.72, p=ns), self-efficacy with a Greenhouse-Geisser correction ($F_{(1.1,8.4)}$=.76, p=ns), or for weighted self-efficacy ($F_{(2,14)}$=.54, p=ns).

Technology Acceptance and Feasibility - Quantitative Results

As the app is only available on Apple products, only 40% (10/25) of the M4HH participants were eligible for inclusion in the intervention group; 3 self-selected to use the study app (Table 5.4). Of these, 1 owned an iPhone, 1 an iPad, and 1 reported owning an Android-based phone and a tablet, but did not report owning an Apple product. The participant who did not own an Apple product did not return any follow-up surveys, the other app group participants (n=2) returned only 1-month surveys. At 1 month, 1 participant reported using the study app 2-3 days per week, for about 10 minutes each time, the other reported that they were not using the study app. All of the educators owned an Apple device.

Table 5.4. Device ownership of educators and participants (app and no app combined) in the Meals for a Healthy Heart program.

Device	Educators (N=10)		Participants (n=25)	
No mobile device	0/10	0%	5/25	20%
Apple				
iPhone	6/10	60%	9/25	36%
iPad	9/10	90%	3/25	12%
Any Apple device	10/10	100%	10/25	40%
Android				
Android phone	4/10	40%	11/25	44%
Tablet	0/10	0%	3/25	12%
Any Android device	4/10	40%	13/25	52%

Participants reported on the frequency of app use in general, health app use and diet/nutrition app use (Figure 5.2).

Educators also reported on their own app use (Figure 5.3) along with how often they recommended apps to program participants (Figure 5.4). None of the educators reported recommending apps often or frequently in Extension programs, 8/10 reported that they sometimes recommend nutrition apps.

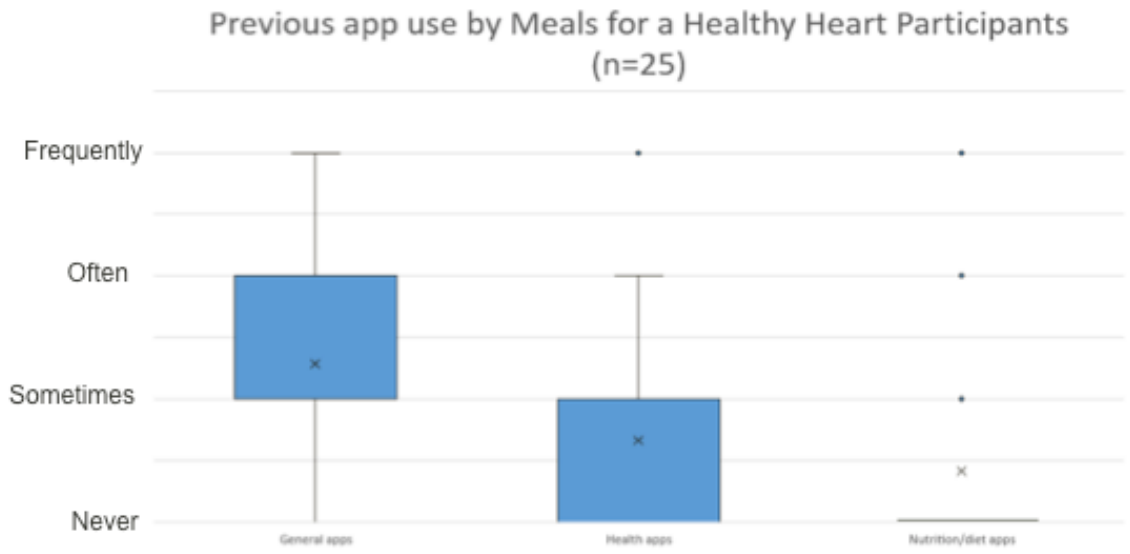

Figure 5.2. Previous app use by meals for a Healthy Heart Participants (n=25).

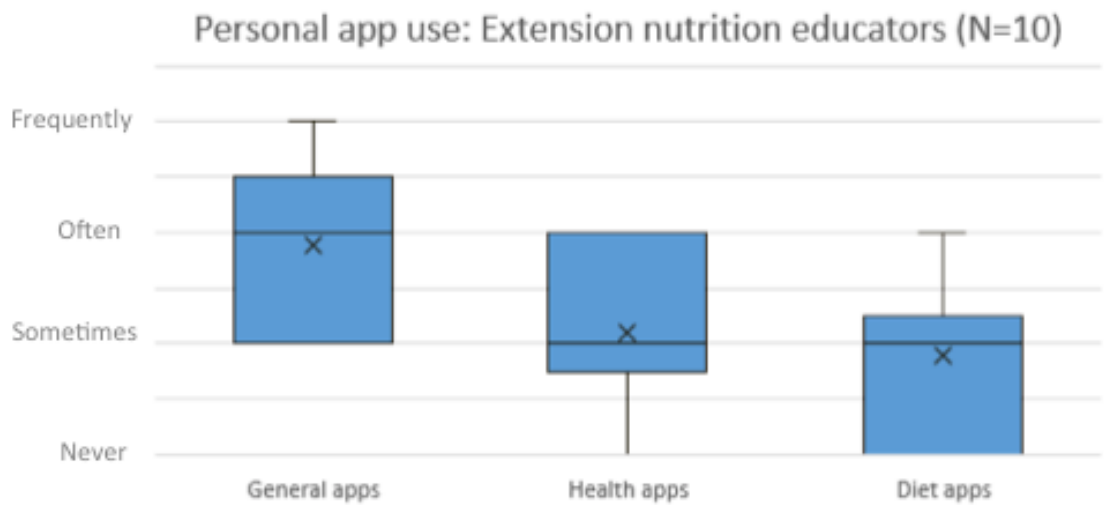

Figure 5.3. Personal app use: Extension nutrition educators.

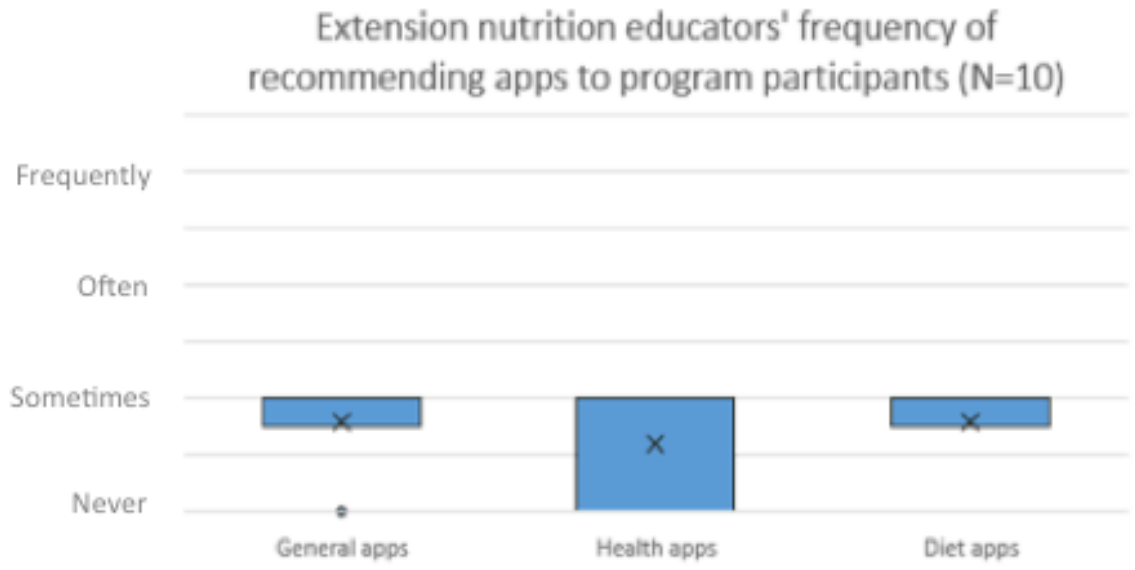

Figure 5.4. Extension educators frequency of recommending apps to program participants.

Unified Theory of Acceptance and Use of Technology constructs were measured in the participants at all 3 time points, and in the educators at the completion of the study. Only 9 participants completed the surveys at all 3 time points, none of these were app users. Repeated

measures ANOVA was used to test for differences in UTAUT constructs over time in these 9 participants. Data were normally distributed for all but the second time points of performance expectancy and social influence. Where the assumption of sphericity was not met, the Greenhouse-Geisser correction was applied. None of the UTAUT constructs differed significantly over time (Table 5.5). Data were included only for participants who returned surveys at all 3 time points. As none of these participants used the app, no changes were expected.

Table 5.5. Unified Theory of Acceptance and use of Technology mean scores for Meals for a Healthy Heart participants at baseline, 1 month and 3 months with *post-hoc* comparisons to baseline.

Construct Scale		Mean (SD)	*F*-statistic	*p*-values for post-hoc comparison to baseline with Bonferroni correction
Performance Expectancy (n=9) 0-24			$F_{(1.2,9.4)}$=.15, *p*=ns	
	Baseline	15.6 (4.3)		
	1-month	14.9 (2.9)		1.0
	3 months	15.8 (3.8)		1.0
Effort Expectancy (n=9) 0-24			$F_{(1.2,9.8)}$=1.4, *p*=.67	
	Baseline	14.2 (4.1)		
	1-month	17.0 (4.7)		.77
	3 months	17.0 (3.8)		.72
Attitude (n=9) 0-24			$F_{(2,16)}$=.28, *p*=ns	
	Baseline	16.3 (3.4)		
	1-month	17.1 (5.3)		1.0
	3 months	16.1 (3.3)		1.0
Social Influence (n=9) 0-24			$F_{(2,16)}$=.93, *p*=ns	
	Baseline	12.2 (2.0)		
	1-month	12.2 (5.6)		1.0
	3 months	14.3 (4.1)		.83
Facilitating Conditions (n=9) 0-24			$F_{(1.1,9.1)}$=.70, *p*=ns	
	Baseline	14.1 (6.5)		
	1-month	16.0 (5.0)		1.0
	3 months	16.7 (3.6)		1.0
Self-Efficacy (n=9) 0-24			$F_{(2,16)}$=.37, *p*=ns	
	Baseline	16.7 (2.6)		
	1-month	15.7 (4.3)		1.0
	3 months	15.7 (3.8)		1.0
Anxiety (n=8) 0-24			$F_{(2,14)}$=3.3, *p*=.06	
	Baseline	10.5 (6.0)		
	1-month	6.6 (4.9)		.46
	3 months	5.0 (4.8)		.20
Behavioral Intention (n=8) 0-18			$F_{(2,14)}$=2.2, *p*=.15	
	Baseline	7.4 (6.3)		
	1-month	11.8 (3.3)		.48
	3 months	10.8 (3.7)		.47

Differences between the educators and participants' baseline responses in UTAUT constructs were tested using 2-tailed independent t-tests (Table 5.6). When data contained outliers or normality was violated as indicated by Shapiro-Wilk statistic <.05, Mann-Whitney-U

test was used. Levene's test for equality of variances determined if data is reported assuming equal variances or not. Participants reported higher performance expectancy regarding diet apps than educators (p=.005). Educators reported lower anxiety scores regarding the use of diet apps compared to participants (p=.001).

Table 5.6. Analysis of differences in mean Unified Theory of Acceptance and use of Technology scores between Meals for a Healthy Heart participants at baseline and educators.

	Participants		Educators			
	n	Mean (SD)	n	Mean (SD)	Test statistic	p-value
Performance Expectancy	24	15.6 (3.8)	10	11.0 (4.7)	U=46.5	.005*
Effort Expectancy	23	15.8 (4.2)	10	17.2 (3.3)	t=-0.9	.35
Attitude	24	16.5 (3.9)	10	15.6 (3.8)	t=0.6	.54
Social Influence	23	12.6 (3.0)	10	11.2 (4.3)	U=104.5	.67
Facilitating Conditions	23	15.8 (5.1)	10	16.0 (3.2)	t=-0.12	.90
Self-Efficacy	23	16.2 (2.6)	10	16.4 (3.4)	U=112	.90
Anxiety	22	10.8 (6.4)	10	4.7 (2.9)	t=3.7	.001*
Behavioral Intention	22	10.0 ± 5.8	10	8.9 ± 3.9	t=.56	.60

U = Mann-Whitney U, t = independent samples t-test.

Educator Technology Acceptance and Feasibility - Qualitative Results

Qualitative interview questions were designed to assess feasibility of both the app and M4HH in terms of acceptability, practicality, and implementation.[7] Responses were coded both according to the areas of feasibility and the UTAUT constructs. Initially, responses were summarized according to the feasibility framework; however, this led to the division of quotes with similar themes. Analysis with UTAUT as the primary framework allowed quotes in a common theme to remain as one group. Therefore, responses regarding the feasibility of the app are summarized according to UTAUT constructs and moderating variables, with the area of feasibility addressed listed with each theme. Table 5.7 shows how each aspect of feasibility aligned with UTAUT. No themes were identified regarding social influence. Performance expectancy was related to acceptability and implementation themes, while experience was

related to implementation and practicality concerns. Effort expectancy, facilitating conditions and age were related to all 3 aspects of feasibility.

Table 5.7. Unified Theory of Acceptance and Use of Technology's (UTAUT) relationship with types of feasibility.

	Type of feasibility		
UTAUT Construct	Acceptability	Implementation	Practicality
Performance expectancy	x	x	
Effort expectancy	x	x	x
Social influence			
Facilitating conditions	x	x	x
Age	x	x	x
Experience		x	x

Performance expectancy is the belief that using a specific technology will help a person improve performance.[16] Many of the educators' responses regarding the acceptability of the app related to performance expectancy. A frequently occurring theme was that the apps were a good fit for M4HH because of the emphasis on the DASH diet.

> *"I think they link up really well because the app covers the DASH diet. We talk a lot about the DASH diet and the Mediterranean diet in the program. So it's completely the same subject matter that we're covering there."*

> *"I do think they [the app and M4HH program] complement each other. When we talk about making healthy choices and how to go about doing that, I think the app really plays into that. It helps with again the tracking, so they are able to know what a heart healthy option is. Cause that was one question that came up quite often was, 'So is this a healthy option, does this have a lot of fat in it? Is this going to be okay?'"*

> *"I think specifically since we spent time on the DASH eating plan that, and if people were really interested in trying to incorporate that plan and you know into their daily lives, that the app would be you know great for them. So I think it kind of goes hand in hand."*

On the other hand, one educator expressed concern since the app only provided information on the DASH diet, and the program included additional aspects of heart health.

"DASH isn't the only thing we talk about, so it's not a program on the DASH diet…It's a good addition but I wouldn't want it to be the only focus for the program."

Educators also indicated that an app would provide a useful method to support follow-up after M4HH had ended.

"So I think having that continual reminder, because I think behavior change occurs over time and I think that behavior change for most people is going to be based on the type of relationship and how much they have invested and I think that by them saying, 'hey I want to participate in this app' and by them saying, 'I want to participate in this type of community event' with regards to having like constant reminders, I think like that helps to better inspire people to create changes in their lives."

"Yeah I think it gives accountability number one. You know, they, they are also kind of, it's more kind of like a follow up. So you know that's kind of the bad thing now is that we give them instruction but we don't see them again. And we don't have any kind of really you know any kind of discussion or anything with them after the program. We might, I think we do have that 3 month eval, that we do send to see how they have been doing but there is not any kind of you know, kind of follow up other than that. So I just think that it will be really nice because number one, it gives them, it gives them kind of something to remember the program by, and remember what they have learned and you know they are using this app, it something that's right there. It gives them kind of more of accountability to continue with the diet and to make sure that they are doing, kind of, you know, what they are supposed to be doing."

"Yeah, but not just follow-up it's going to be like more of a relationship between like the app and the person."

With regards to performance expectancy, 2 themes occurred when responding to both acceptability and implementation questions. One of these was that the app would be a good additional resource. Many of the educators expressed that they would like to see information on the app, or multiple apps added to the Extension website. Some explained that they would direct people to the website for more information, while one felt the app could be a standalone resource separate from the M4HH program.

"I think it's a really nice resource. We give them handouts; we give them recipes so this to me is a very nice addition to the program to say here is an actual skill set you can continue on."

"And I think that's where too like an app could be useful because then it is them managing, you know, their diet and them kind of having that tool in their pockets that they can actually use. Instead of a program where they just come, they hear about what they should be eating or what they should not be eating and then, you know, that really doesn't resonate, it really doesn't resonate, you know, really doesn't stick with them."

"I would like to see [apps] to be available as something people could download from our website. So if they went into nutrition and wellness, there could be a section there that they could get that app if they'd like to."

"Saying like, "Here is a really good list of apps that we have checked out that have, you know, lot of good reviews." Maybe you have like 3,4,5 of them."

"You know, because it might be something that people pick up. And it might be even something that we can just have available online, you know, because some people don't like to come to a program but if they can jump online and access an app and some quick information through our resources then that might be a way for them to learn."

The other performance expectancy theme from both acceptability and implementation questions was concern that M4HH participants had general lack of interest in using apps.

"My main issue was, again my population I was working with, I don't think they were, nobody was really pushed back again it, but they didn't seem to have that interest in using it beyond the program."

"I guess it just takes a lot of commitment on the person's part to put things in every day. And if they are not really wanting to do like any kind of nutritional diary, you know some people just want to come for the information and I don't know. Maybe a lot of people just aren't interested in like doing a day-to-day thing after the program is over. I don't know. I just didn't have a lot of people interested in the app so I can't really say too much either way on this subject I guess."

"There just wasn't a lot of interest in using an app."

"…I asked if anybody had an iPhone…and I told them when they were filling out that survey that they had the option, and if they wanted to learn more and I didn't have anybody after program say anything to me about it [the app]."

"Do they really care to track what they are doing? Or it's kind of like…the stages of change, are they open to that or is it something they go, "I don't know if I want to do this quite yet."

While the general consensus was that the app studied was a good fit for M4HH, concerns with lack of interest in the app were expressed. Educators seemed more interested in the app as a supplemental resource than as an integral component of M4HH. While interviews were not completed with participants, performance expectancy of the participants was slightly higher, as they somewhat agreed with the performance expectancy questions regarding apps than educators who reported neutral performance expectancy in the quantitative analysis (p=.005).

Effort expectancy is the perceived ease of using a technology.[16] When responding to acceptability questions, educators provided conflicting feedback, with one response that an app would be convenient because devices are portable and readily available and while other educators expressed that apps are cumbersome to use.

> *"Well I mean I use apps so I think you have your device with you mostly, you know, most of the time. I do, it's like my wallet or my driver's license. So you know, downtime it's easy to get, you know, its, you know, kind of do your thing, get the questions answered or put your data in and it's just, it's just convenient rather than trying to make time when you get home, when you have you know, have to make dinner and have other things. It's easy to use like, apps are easy to use in downtime. That's the way I look at it."*

> *"So I would just say what I just said you know, the fact that they are cumbersome."*

> *"And that absolutely sends me over the edge. And also it [using an app] just takes so much time. You know I've been a Weight Watchers' person for years and I have the points pretty well memorized and I can jot it down in my notebook in a fraction of the time it takes me to input it into a phone."*

Educators also expressed concerns related to effort expectancy when answering implementation and practicality questions. A few of the educators expressed concerns over the usefulness of the app the efficiency of spending program time on an app that only some participants would use. It was recommended by these educators that before incorporating an app into the program, educator buy-in would need to increase.

"Every app that I have ever tried assumes that you purchase prepared foods. You know what I mean, when you are searching for the foods and I have not done the DASH one, but when you are searching to give yourself credit for having eaten xyz. You know you can't just find: I made myself an omelet and it had this and this and this in it. They want you to buy the [name brand] prepared omelet."

"You would need to sell me on it first."

"I don't know, I just, just from the last time I mean I only had that 1 person, so I don't know if it would be very efficient to keep offering it."

"I think a lot of it would be just again whether or not people are really going to use it and I think you will, I think maybe I would find that I would get a few out of each program using it. I don't think, you know, you are ever going to get that 100 percent, which that's not maybe what you are aiming for anyways but…you are not going to get too many people so then it's like, okay are you spending too much time, what's your productivity? Are you spending too much time trying to get them to learn this and then not even use it?"

Both the educators and the participants reported slightly positive effort expectancy in the quantitative analysis.

Social influence is the perception that important others believe that technology should be used.[16] While there were no themes regarding social influence, one negative case did occur. Educators expressed that keeping up with technology was an important goal within the Extension system.

"I think it's something that as time goes on obviously technology keeps changing and that's the thing, we need to keep up with in Extension is making sure these apps and that we are keeping up with technology. And finding ways that we can implement them into classes."

In the quantitative analysis, both the educators and participants reported neutral responses to social influence.

Facilitating conditions is the individuals belief that both organizational and technical infrastructure exists to support the technology.[16] Themes related to the organizational infrastructure included the implementation concern that the app would need to be better

integrated into M4HH in order to be successful. This included integration into the program itself and into marketing efforts.

> *"...maybe implementing it [the app] a little bit more throughout the program. Usually we have them for a total of 4 hours. So even like I said, mentioning it at the beginning and saying, 'well if you are tracking meals this is a great way to do it, you can use this app.' And kind of explain it further without really pushing it upon them, just giving them extra suggestions, or even throwing it into our research page we give out. Just yeah finding ways we can implement it to show how they use it, to show how can this be part of your life as opposed to just talking about, 'Oh this is the app, you have the option.'"*

> *"I would think it's something to discuss is the DASH diet app, when we get to the point in the lesson about the DASH diet. I think that a good place to pause and then talk about the app, and not necessarily starting out the program with it."*

> *"I would say possibly advertise it [the app] in the description as, when the program is being marketed, as a possibility."*

> *"...introduce this information early. To include it in the media information that's sent out, press releases and so on, that the app will be part of the lesson. How to access that information in the press release."*

When asked to explain in what ways an app would be impractical, a few educators expressed that the $1.99 cost of the app was a barrier.

> *"Professionally I would say that I would see the cost being a barrier."*

> *"Yeah, so that could be a barrier, and you might think, oh you know 2 bucks or 2.50$ or whatever, again people like in the area I work, I think they are very stingy. Like they complain about having to pay a 10 dollars for like a program. I'm like 10 dollars for two hours with a registered dietitian. How much would you pay at a hospital, seriously?"*

In regards to technical infrastructure, there were both implementation and acceptability concerns about participants not owning app supporting devices. In addition, questions from all 3 feasibility areas, implementation, acceptability, and practicality, elicited responses regarding concerns with inadequate Internet access to support app use.

> *"I think the major thing was they, they didn't have a smart phone."*

"I think a percentage of the people didn't have an iPhone or an iPad."

"I think the number one issue was that people just didn't have like a smart phone."

"Again depending upon the community that it's being offered, I think in a lot of our urban or larger communities having Internet access or having good cell reception is not an issue. But I think in our more rural communities and I think in our like, up in the northwest corner it's really hilly it's not like the rest of the state that really flat because this area was essentially untouched by the glaciers or some type of story regarding that. But so it's really uneven and even having a radio station the reception comes and goes."

"…concern with regard, not all of our, in fact probably only half of the places that we teach the program have internet access. It depends on the location."

"I live in a rural community, limited internet access in 2 of my counties for sure. The hills in 2 of my counties. So I think like in an urban setting where people have you know all those other easy access cell reception or whatever I think that would be ideal. But I think in a more rural community that may not be the best option because just the feasibility of it."

A number of the educators also explained they would need technology support available in order make offering the app practical.

"When you said that I was thinking we would need, whoever developed the app, if the client using it has issues they would presumably go to there the app tech support piece. Not necessarily support from Extension, cause we wouldn't own the app, we didn't design it and we don't know how it works. They do, so they would have to fix any errors when they pop up."

"I'm not sure if there is specific support that we need for the app in terms of IT support, although we may want to look at that as an option with our campus IT, making them aware of apps that we are using for our classes. Cause we have been told a couple of time, do not do…updates for certain programs on our campus computers. There is something they said they still need to fix this, either you have an update that's supposed to go through but they have got kinks that they need to work out. They tell us, 'Don't do this right now. We will let you know when we have evaluated it and we think it's good to update.' So that could be a piece of having our campus, our Extension campus folks aware that we are using the app and is there something that we can kind of put on your plate. So if the client comes in and says, 'I'm having issues,' we can send it to them."

While numerous concerns were raised regarding facilitating conditions, educators did express that for those who were already using technology to find health information, providing education

and guidance would be a practical use of Extension time. Those that felt it would be a practical addition to the program provided reasons including that the participants had the devices and were already using those devices to find information, so as educators it would be beneficial to provide guidance on where and how to find and use the information.

> *"Yeah it's very practical because people are accessing information online anyway. So we may as well steer them to correct information. And information that will actually help them in that endeavor to eat meals that are actually going to help with their preventing heart disease or support whatever condition they already have. So I think that the information is out there, people are accessing quack information's dot coms, websites instead of .edu's and so this will help to steer them in the right direction."*

Both the educators and participants somewhat agreed that facilitating conditions would support app use.

In addition to the main constructs of UTAUT, the theory describes variables which moderate the primary constructs effect on intention to use apps and actual app use. Two of these moderators occurred as themes in the responses of educators. The first regarded the age of participants. Responses to acceptability, implementation, and practicality questions all included concerns with the typical age of participants in M4HH.

> *"Well I didn't have good luck because of the age of the participants."*

> *"I would say for the most part, the participants were older, except for one couple that did say they wanted to use the app. They were probably in their 30's."*

> *"I think it was more of an age issue. Personally that what's I think."*

> *"I think the number one barrier that I would see is that, simple demographics. Our demographics for this program has primarily always been 61 in age or older. And you know that's, that's not to say that, that age group doesn't have maybe a smart phone to be able to use an app but of course it's a demographic that is going to be the least demographic that's going to…have a smart phone, and to use the smartphone and to be comfortable with it. So lot of them I have known do have smart phone and some of them will kind of have maybe some apps but they are really not sure how to use it..."*

"…they [M4HH participants] are older and they prefer kind of the classic version. If they meal track they will do it on paper, they won't use a phone to do it."

"I just don't know if a lot of people in that age range that we typically see are going to be that interested in doing the app. I haven't been offering it long enough to know if they are or not, that might be something useful to find out. Like if you maybe had a whole list of all of the past participants and surveyed then and say, "Is this something that you would do if it was available to you?""

While age was identified as a barrier to using the app, some of the participants expressed that the app might be useful in targeting a younger audience, or to use with the younger generations as they age.

"I think it's practical for a certain population and I think there are that younger population, if they understood it and how it benefitted them, would be interested in using it. But I don't think it's as practical for the older participants. Although you see some older people that are very computer savvy and use the computer and apps so I don't want to stereotype."

"…as time moves on with M4HH, I think it's something that might give us the option to market to a younger audience."

"I think that also would help me market to a different population of new participants."

"I really, you know, I think people younger people that are, will get heart disease based on maybe life style factors or genetics and they are in their 40's or 50's. You know, I think that kind of audience might be more apt to participate with responses on an app and more comfortable on an app."

The other moderating variable was experience with technology. Responses to implementation questions indicated M4HH participants lack experience with apps.

"So when I asked her if she would like to do the app she was not able to do it just because of her experience with social media and with you know, the app."

"The only thing that was really an issue when I talked about the app was a lot of them weren't familiar with, they didn't do a lot of tracking from what I gathered from them at least. From what I talked to them about it."

"…I think that might have been a big barrier too is they weren't really comfortable using apps. Cause I did have to explain to somebody what an app was."

"I don't know how many of them use apps already so it might be kind of a new concept."

In response to both implementation and practicality questions, educators emphasized that M4HH participants would need more education to utilize apps effectively. The educators specifically emphasized that the participants may need more training on how to use the app.

> *"…if they did have some additional training that they would [be comfortable with the app]. And I think some of them would appreciate that because a lot of it just simply not knowing and not having anybody just sit down with them to really explain it you know. They always talk about, 'Oh my grandchild know how to do all this but you know, I don't know how to do it.' And so it might just be that, might just be someone sitting down with them and having a program on it. You know, it might be something that interests them."*

> *"So just navigating through the different features, how to access it, how to put things into it. I mean it's probably a learning curve for some. So just adding in that extra time to help them through that process."*

> *"…maybe let them sit through the program and maybe have a follow up on the app and help them get started on it if they wanted to possibly. I don't know if that would help but I guess that would be my recommendation."*

> *"…maybe going through and giving like a day's example of recording on the app and maybe have them do some hands on practicing. Maybe from what they had had to eat that day so far or something."*

Similarly, one of the educators emphasized concern over a lack of personal experience incorporating apps into programs when responding to an implementation question.

> *"I think even just a lot of us, have, you know, we haven't used apps in our classes before. I know I have not ever used an app in my program. I do have one program where I do spend, oh only 5 to 10 minutes talking about apps and I give them kind of some examples of different ones and that program was about meal planning. And so I give them different examples of meal planning apps and talk a little bit about how you can use them. But that's the extent as to what I have gone through to actually teach a program with apps."*

Some of the educators indicated in responses to both implementation and practicality questions that they would benefit from more experience and training on the use of apps.

"I would say get familiar with the app yourself, because you know it's nothing worse than trying to teach on an app that you don't even really ever use or know…So get familiar with the app yourself and kind of know the ins and outs of it."

"I think it would be just good professional development for educators to simply you know have some kind of professional development opportunity where we are kind of taught, what are the tips? And what are kind of the ways to use something like an app in, in your program? I think that would be the, the most useful thing."

"I guess I would have to use the app myself."

"I think it would be a good recommendation that we as educators maybe trial it for a week or two so that when we are speaking on it, we are speaking from experience and not just generalities of 'You enter in your food and it calculates how many vegetables you ate.'"

"Well I'll need some training."

"That's a good question. What resources or support would I need? Hmmm, it would even be nice for within Extension, I mean as professional development, as…our nutrition and wellness team to get an even better grasp, cause I did download the app. But it would be great if for even us to get together with let's say you or the developer and really talk about the app in detail just so we have an extreme understanding of how to use it."

Most of the educators (8/10) indicated that they had previous research experience; all indicated previous experience with program evaluation. Since the interviewed educators included both those who used the app and those who never had, identification of similarities and differences between responses of the 2 groups of educators was examined. Educator responses were similar between those that offered the app and those who did not with regards to concerns with the age of the participants, a lack of personal interest in apps on the part of M4HH participants, and with the cost of the app. The theme that an app could be a useful tool relating to the DASH content of the program was also expressed by both groups of educators. Educators who did not offer the app placed more emphasis on a concern for lack of participant experience with apps and the need for participant training in the use of apps. The educators who did use apps expressed concern with using a DASH app in a program that was not only about DASH had

not offered the app. Those who did not offer the app contributed more regarding the theme that the app would be useful for program follow-up.

Educators provided responses to questions on the feasibility of M4HH designed to assess acceptability, implementation and practicality of the program. These 3 feasibility aspects were used to summarize educator responses.

Acceptability items examined reactions of educators and perceived reactions of participants to M4HH.[7] Quantitative data showed low demand for M4HH. Educators' responses were consistent with this. Educators reported that M4HH was only held if 5 people signed up, although 1 educator reported holding the program once with 3 participants. The largest program size reported was 22 participants. A frequent theme was that while heart health is an important topic, demand for M4HH is low. This was expressed by educators who held programs for this study, who offered the program but did not get enough enrollment, and who did not offer the program as a part of this study, but had previously offered M4HH.

> *"I expected there to be more demand. I'm not seeing a high demand for it."*
>
> *"Normally I don't see a high demand and that's one of the things that always just kind of gets me, because it's like, okay so number one killer, you know heart disease."*
>
> *"Demand? Haha I have had to recruit people."*
>
> *"I haven't had a lot of calls on heart health. It's mainly like groups area already meeting or worksite groups that want someone to come and do some lunch and learn."*
>
> *"Well the thing, we have talked about this a little bit, me and my county director. As I said [county name] is one of the highest in state for heart incidents and heart disease and I keep saying to him, I tried to offer that program so many times and we don't get a population come out to it. And it's because those people aren't seeking help."*
>
> *"M4HH is probably a lower demand program than my other classes.*

Only 1 educator expressed that M4HH was well attended compared to other programs. She was one of the educators who held the program for this study.

> *"Probably the most is definitely M4HH. I think that's the one I have had the highest attendance with. The diabetes one we have done a couple times and once again if I partner with a hospital usually we will get 10 to 12 people, but most of my M4HH I have had 12 to 15 in it every program I have done."*

Many educators emphasized that M4HH and other programs on chronic diseases were not as well attended as programs that were more for entertainment value. This included educators who held the program, those who canceled the program, and who did not offer the program for this study.

> *"…I think like the feel good classes, the warm fuzzy classes like cooking with culinary herbs, having infused vinegars, the science of chocolate, you know. Those like one shot, I think people go to those kind of a little bit for entertainment and "hey let's go to a chocolate program", you know, to have fun versus like oh my gosh, lets acknowledge that you know that I have heart disease, that I have high blood pressure. You know, that I need to change something and that acknowledging that makes a person, vulnerable. So maybe they will or will not want to do it. So I kind of think that the warm fuzzy classes are better attended compared to like, "Oh my gosh this is like a real life issue that we need to be thinking about."*

> *"And it [another program] meets 9 times a year and it's a program that focuses on using and purchasing locally grown foods. It's also not a cooking school but a cooking demonstration, where I prepare meals based on a theme, it can be an international cooking theme or it can be whole grains or using fish and this, people love this program, I mean, they like to watch the demonstrations, they like to sample recipes, they have told me in follow up evaluations that they have learned cooking skills, they have learned to incorporate low fat cooking methods and reduce the sodium by using more herbs and spices. So, that program meets once a month 9 times a year and it is overflowing. I have a waiting list always so I can only take up to 30-35 people in the program, cause I can't, I can't make more food than that, you know?"*

> *"Yeah, just getting them there. It seems in general that our programs on chronic disease although people, we all know that there are plenty of people that need education about heart disease and diabetes. But I don't know if it's just that they heard it so much from their doctor that they just don't want to sit and have somebody tell them something that they know that they need, but maybe they don't want to do. You know they tend to like the kinds of things that are more fun or light I guess."*

"But I'll tell you a program, something like, we have a program about crockpots. Oh my goodness, people just love that, we got 30-35 people to come to something like that."

Some educators also felt that programs targeting other diseases such as diabetes or continuing education were better attended than M4HH. This included all 3 groups of educators (program offered but cancelled, program held, and program not offered for this study).

"We established, so I have been here almost 4 years and so we established that unless we have at least 5 people we are going to have to cancel the classes. And so I would say that, well, I would say that the I on Diabetes program, attendance has been better compared to the M4HH."

"All across the board ummm. Food Service/Sanitation program, I get a lot more, more like 20. Between 15 and 20 I would say, and I think it's because you know they have to have it. It's a certain target group that has to come."

"And I always feel like I get a much better attendance and a much better kind of just interest in diabetes classes."

"Ummm, I would say with the diabetes it's about the same although, I have had greater numbers some years."

Some educators who had offered M4HH in the past although were not offering the program as part of this study also expressed that a strategy they successfully used to increase attendance was to partner with another organization.

"I also offered it at our senior housing, government housing and that was as high. So occasionally I'll be able to swing things like that but for the most part we are talking 6-11."

"Basically what I have done with M4HH is I get the most participation when I run it with a partner. They are [the] senior center, they are very active, you know, they have like a 130 people that participate in lunch, they have woodworking, they have yoga, they have just about anything you can imagine there and it's a very active senior center. So you know I've been an educator, it will be 6 years in July. So I started you know offering things in the counties, but I didn't really, you know, I like to [have] at least have 10 people before I put that kind of time into something. And I end up at [the] senior center starting with 22 as opposed to 10. They buy all the food."

While educators expressed that finding a partner was helpful, one educator whose program was cancelled expressed that they felt they were in competition with the local health organizations.

> *"...sometimes I feel that I am in competition with some of the larger like health care facilities, hospitals, clinics because they have big advertising dollars, they can offer programs free of charge, they can have health care providers refer patients to classes, to group community classes. Versus I don't think that we have necessarily the marketing power to truly reach the individuals that that I personally would like to."*

A few educators expressed that attendance had decreased over time in M4HH.

> *"So I found over the years I've gotten fewer and fewer enrollees. Some people will enroll twice in the program. They have taken the program more than once, which is fine, you know."*

Some educators also explained that other events in the community impacted enrollment. This included both those who held the program and cancelled the program.

> *"This last month I cancelled because I had 2 that signed up and I was told by 1 of our secretaries in that county that there were lot of other things going on that week in town."*

> *"A lot of factors go into it, you know, time of day, day of the week, what else is going on in people's lives during that time of the year."*

> *"I think there was a lot of school things going on, you know sports, which is a big thing when you are a small town. It makes a big impact."*

Another explanation provided by educators was that the 2-program commitment decreased attendance. These were educators who held the program for this study.

> *"But yeah that's been probably our biggest barriers, we are trying to figure out ways to offer the program. And being it's only a two, it's only a 2-program commitment that we have talked about too, is there a way I can convert it into a 1 program. One and done, rather than having them come back once or twice."*

> *"So if people can't make it to you know one of the nights, they are not going to sign up for the whole series, because they don't want to miss any."*

Although educators expressed that the 2-program commitment was a hindrance to enrollment, once people attended, the program was generally well received.

"I will add this, the people that have come to like the I on Diabetes which is like a 4 part series, or the M4HH, the comments that I hear from the individuals are, 'Wow, I learned more from this program than I have from, like when I when and had an appointment with a dietitian or the diabetes educator. I have learned.' They made comments in reference to learning a lot more, not realizing various things."

"And it's also kind of nice to see the dynamic of the group. In like, for M4HH session 1 versus session 2. Because they kinda have that commonality, they have kinda gotten past that you know, "wow I don't know who is sitting next to me" type deal. So I definitely think that when you are looking at behavior change with regards to changing health outcomes that having series of classes is really important. I just think that there are so many things in our modern society that is in competition with being healthy compared to having fun.

A final hindrance to enrollment that was discussed was the cost of the program. These were educators who held the program for this study.

"And I don't know, sometimes I think it could be a cost factor. We charge $15 for the Meals of a Healthy Heart for they basically get a meal both nights and the same with the diabetes. But I charged as much as $45 for the diabetes for the 4 series and people didn't seem to have a problem with that. Now the last two times I have taught it we have gotten some funding from a local cosmopolitan club and their mission is diabetes education so they have covered the cost of it. But beyond that sometimes for people with fixed incomes that an issue."

"And that's, we are trying to lower because we have a cost to the program which worried me that that's why. So usually when I partner with a hospital sometimes they will help cover some of that cost, so then the people won't have to pay for the program. So that's one thing we have talked about finding a way to kind of recoup that cost."

Others saw a small fee as a way to increase participant dedication.

"You know we struggle with this in Extension, you want people to have skin in the game. You want them to think the program is worth something, so sometimes you charge a little bit to give that. Usually when I charge for a program it's just to compensate for supplies…Fine line between okay if they are already paying taxes this is part of the service of the land grant mission and then the other part is, do they have skin in the game? If they pay a fee they will think twice before they skip the program that sort of thing."

When asked about demand for M4HH, one educator who held the program mentioned marketing.

"I think possibly [if] we had more marketing resources, it probably would be more popular or we would have largest classes, you know, if we had a marketing person or somebody who spends a little bit more time recruiting participants other than the standard putting it in the newspaper and sending it out to, you know, different partners who we do programming with. But it seems to be kind of standard across the states. It seems that everybody is having the same issue. And once people go and attend, they appear and, you know, they are evaluations that they return are always positive. So I don't know if its maybe them not really knowing what it is, or, or, or, what maybe they would benefit from it. But, obviously there is not a huge demand or there would be more people coming to the classes."

Implementation items assessed the likelihood that M4HH was and could continue to be implemented as planned.[7] The educators reported offering M4HH most often in February for Heart Health month, although some educators reported offering it at other times of year as well. Each educator reported offering the program anywhere from 0 to 3 times each year. The program is planned as 2 sessions meeting for 2-3 hours each, and most educators reported offering M4HH in 2 sessions, although 3 of the educators reported that in the past they have offered an abbreviated 1-time version of the program. Some who offered the program for this study and in the past expressed that they shorten the program or decrease the number of recipes used in the program.

"I did have to take out some of the content…I did want to keep it short enough to where, you know, it was a two-hour program not anything longer. I did not, you know, want to have them there for longer than that because I was afraid too that that might, you know, cause some people to not come or whatever."

"I will try to shorten the recipes. I think this time around I actually did take away one, because I usually do a main dish, I do a side dish and I do a desert. And I did a desert but I did one that was a little bit simpler just because I knew that they were a chatty group and I got a lot of questions so we didn't stay there until 10pm."

In contrast, one educator who had previously offered M4HH mentioned that she made the program longer. This educator did not offer M4HH for this study, but had delivered M4HH on other occasions.

> *"I do modifications because we had a long version and a short version and to the paired down version, I don't feel is as comprehensive as a lot of people would like information on. So I actually do a modified version, a much longer version."*

Another mentioned that the surveys for the study took an extra hour of program time.

> *"Because of the survey we did in that first program we were probably in there an extra hour."*

The M4HH curriculum had been updated by the educators shortly before the start of the study. A common theme when asked about how the program was implemented was that no changes were made, as this was the first time the educators had taught the program since the update.

> *"I always try to make sure everything is up to the current recommendations for like sodium and what not, but they recently had made changes to that so I didn't really have to go in and do any alterations."*

> *"I really didn't do a lot of modifications to this first time around just because I wanted to see if there was any kink, anything that we needed to fix."*

Educators expressed that when they changed the program from the intended content or length during this study, it was mostly minor changes. This included additional handouts, and personalizing the program.

> *"Of course all of us educators personalize programs but that's a state wide initiative so I pretty much stick to the script that's been provided and add things as needed."*

> *"I make some minor modifications. Generally, maybe supplement with some materials at times. It kind of depends on the audience and maybe what their questions are and if they ask specific questions about something that's not covered well then maybe I might supplement some information for them."*

Educators discussed barriers specific to the implementation of the M4HH program. A common barrier was recruitment of participants to sign up for M4HH. This included those offering M4HH for this study, those with canceled programs, and those who had offered M4HH previously.

"Hmmm the largest or greatest barrier is just getting people to come. Um and seems that, I don't know, I have better luck in 2 of my counties than I do in one, but just getting people to register and come is usually the greatest barrier."

"First barrier is getting them in the seat. So yeah like I said, just simply, you know, number 1, marketing it. That's always a barrier, no matter what program we have, just marketing is just tough. How do we get, how do we get the information into the hands of the people who want it and need it? So marketing is always a barrier and just getting them to come."

"…they just don't turn out as well in this county. And I think maybe it's the rural nature of it. Maybe they are just not as accustomed to going to this type of a program possibly."

A similar concern was saturating the market if a program has been offered in the same area too many times.

"It's kind of a hit or miss, have noticed that with most of our programs, if you offer it enough you start to saturate the market and so there is just not enough audience members that want to participate because the ones who already have don't necessarily want to go through it again."

"but once you do something a few times, the people that have been around you are saturating your audience. So you know once somebody has done it once, will they do it again? Sometimes."

Some educators who had offered the program previously and who had the program cancelled saw the two-session time commitment as a barrier to M4HH implementation.

"but I think the 2-time commitment can be a little challenging cause things come up and maybe you can't come one week."

"I usually have cases where 1 or 2 people don't attend both sessions and that throws off our evaluations and that's the biggest barrier. Making sure that people attend those sessions."

"When I'm having it with the 2 sessions a lot of times…they all say, "Oh, I can come to 1 but I can't come to the other.""

Another concern among both those who held the program and those who had it canceled was the amount of time and logistics to prepare for a program that involved food preparation.

"Anytime we are working with food that extra time that we the educators have to spend. So that me going shipping for food, prepping food in advance so that's little bit of extra time. I don't know that it's a barrier necessarily but it sometimes feels like extra."

"So that's a lot of time investment, you know, especially going, I'm in [county name], so it's you know I drive 18 miles to get there, you know, and then do all the setup and the prep and everything that goes with that and then other programs aren't as labor intensive, they might not have food with them. They might have activities built it, but whenever you bring in a food factor its always more work, and more time."

"Of course the food is always an issue, thinking about when I'm transferring from our main office here to the location I'm going. But thankfully for the most part that was not an issue this time around, because all the food prepared with only going a mile, not going an hour away from my main location."

Finding an adequate location for offering the program was another implementation concern for a few of the educators who did not offer the program for this study.

"I rarely offer either the diabetes or the heart health in my southernmost counties because the facilities at the Extension office don't lend themselves to cooking demonstrations."

"…for the southernmost county. I just can't find a good location but I'm working on it."

Another perceived barrier was that the information provided was more technical than the audience needed. This included those who held the program and those who did not offer the program.

"I would say just, sometimes, it can be a little technical for the audience."

"Well I think that every time we revise it we make it longer and more in-depth and I think it's more information that most people want."

The educators provided a number of recommendations for implementing M4HH. Educators who offered the program in the past expressed that partnering with another healthcare organization not only increased attendance as previously discussed, it also decreased educator burden.

"Yeah, they [partnering senior center] will make copies if I ask them to, I don't always ask them to, but if I need them to they are willing to make copies. Yeah and they buy the food and I use their kitchen, they have a very functional kitchen. So It's just I do it with them because it's really kind of helpful as far as the workload and also the cost."

"I find a place where people already go and they are established. And you know they do a lot of the work, they do. We do advertising, but senior center also does the advertising and puts it in their newsletter and they are very developed with all that. So partnering with them is a strength that's helped me overcome some of the barriers."

Educators frequently recommended that participant involvement into the learning process needed to be addressed more thoroughly. This included educators who had programs cancelled and who did not offer a program for this study.

"But I found its better when they are involved in it. Which we talk about this all the time with kids, I'm finding that the same is kind of applicable for adults. If they are the one who made the recipes they are more open to trying it versus me bringing out one the recipes and saying 'Here is this recipe, why don't you try it.'"

"Plus I like doing activities because again someone can sit up there and talk, but if you have people engaged in activities such as looking at nutrition labels or putting menu items or foods together to create a meal or something. And then having them have that realization of, 'I had no idea how many milligrams of sodium is in this meal' or 'I had no idea how many grams of fat are in this particular item.' So I like to do those activities, so then it makes it more real and I think by allowing them to have those activities and have that realization its' going to better influence their life choices as they leave the program."

"It's difficult I think to sit and listen, people tune you out, their, their brains are gone, so what good is it. So I think that incorporating more activities where people are actually getting up and moving and doing something, if you are going to lecture for 2 hours, if you are going to talk for 2 hours and it always needs to be, you always need to engage the people who are sitting in front of us, so they are not just sitting and listening. So asking questions, allocating for more interaction between the participants themselves."

A few educators mentioned that providing a connection between the two sessions, or follow-up after the program ended would be beneficial. This included both those who held the program and who had the program cancelled.

"Plus I always, I also assign homework to my classes. Because I want them to have something to do between week 1 of M4HH and week 2. So I always give them a challenge, whether it's like trying a recipe and then coming back and reporting what they you know, did they like the recipe, you know did they modify it, things like that. Or giving them like, 'Hey did you track the sodium content for, you know, two meals over the course of the past 7 days,' whatever, whatever challenge they end up accepting."

"I always like, I always like when we can follow-up with people. And I know we have the evaluations but it's like not very personable. And like with the monthly series I do, I'll see those people for a long period of time, which builds the relationship. With M4HH, some of the programs they are kind of just a one time and you never see the person again. It would be nice if we could do some kind of like meet-up group maybe once a month with those individuals. Sometimes they could bring friends, but it's kind of like a support-group. And I know some educators have probably done that, either with heart health or diabetes and I think that's a really good idea, I think they have gotten a really good response from that. But maybe that's something that we can start doing collectively as a State."

"I think one of the things that I did add because I found from the I on Diabetes program that it was a really good thing, it's was the goal writing for instance, we would kind of write out own, they would write their own goals. And I thought that was a really good thing because you know it's not like I'm writing the goals for them. They have got to come up with their own goals. And it is just kind of a good way for them to start out thinking about why are they there, what are they wanting to see? What are they wanting to do? And so I think that is, that that would be a good thing to add that I would like to see, it's just kind of getting them where it's kind of more self-management of their heart disease."

Many educators expressed that the session time needed to be decreased, or divided into multiple programs covering more specific topics.

"I think sometimes the length of the program might be a bit of a barrier and I know it's two times and it's for three hours each time. But maybe people might be able to come to a program that was an hour and a half, kind of stretch it out a little bit."

"It might be a good advertising to say 'Series 1 or part 1 is blood pressure and part 2 is cholesterol if you want to attend both great, if not they could still be stand-alone classes but commit someone to say, 'Well you know I have never had any trouble with my blood pressure, it's my cholesterol' So they may not feel interested in the blood pressure piece. So giving them that option that might help a little bit, so that they can pick if they want to attend one or the other or both."

"So I could see when we talk about heart health, I know we cover so much and the DASH diet itself covers so much it could be a program on its own."

Practicality items assessed the extent to which M4HH could be implemented within the context of available Extension resources.[7] With regards to the practicality of M4HH, educators were specifically asked if they felt supported in marketing the program. The responses were divided. Some educators reported support from partnering organizations, others reported that they have support from an individual in their unit devoted to marketing, and still others reporting that they had no support marketing their programs. These were educators who held a program for this program or in the past.

"Sure, definitely this time around I did feel very supported by our hospitals in [name of town], I never partnered with them before."

"We have an amazing promotions specialist in our unit and she does a lot of our marketing, most of our marketing. And we haven't always had her. But since we have I think all of our programming in our unit has grown."

"Well each unit in Extension is very different. And so my unit covers 4 counties and we do not have a marketing person in our unit. And it was funny you asked that because that was the one thing that I recommended for my assessment; is that if we had extra money, that I would spend it on a marketing position because for me, you know, I'm doing the flyers, we're sending it to the newspaper, I'm doing all the marketing and it takes a lot of time to do all the marketing. So that's on top of everything else, you know."

Discussion

Principal Results

This study identified a number of feasibility concerns regarding incorporation of an app into the M4HH program. While conclusions cannot be drawn about differences between app users and non-app users due to the small number of participants who elected to utilize the technology (n=3), information can be gained about the feasibility of the M4HH program and the incorporation of apps into such a program. Notable barriers to participant app use included

inconsistent ownership of devices for using apps, lack of interest in apps, age of participants, and lack of previous app experience. Barriers to educator incorporation of apps into M4HH included a lack of experience in using apps as an educational tool, concern that apps may not offer a benefit to the users, and concerns related to Internet access during programs. Participants appeared to have more confidence in apps providing a benefit than educators; however, the participants reported more anxiety about using apps than educators. Instead of incorporation into M4HH, this study suggests apps are better suited as supplemental material for a program, as a standalone resource for those already using technology, and for younger audiences. The educators did provide some positive aspects of the study app and apps in general. The app itself fit with the DASH portion of the M4HH program, and provided a method of extending education beyond the program, something that is not typically feasible within the context of M4HH.

Heart health is a major concern facing the populations targeted by Extension, and Extension's framework positions it to have broad reach in health promotion.[26,27] However, this study indicated that demand for M4HH is low compared to other programs with more of a focus on entertaining participants. Possible explanations for this included a saturation of the market when a program is offered multiple times, participants not being willing or able to commit to multiple sessions, and in some cases a lack of marketing support. Possible solutions for overcoming this barrier included partnering with another health organization such as a hospital or retirement community, and decreasing the time commitment required to attend. Regardless of the low attendance, educators expressed that the program was well received by those who did attend, indicating that the primary barrier to the feasibility of the program was getting people in the door. While statistically significant changes in knowledge and behavior change were not identified, this study was not powered to detect changes. A study examining an Extension

community outreach program in Ohio targeting hearth health and incorporating the DASH diet indicated that Extension programs can promote changes in knowledge and behavioral outcomes.[26]

This study adds to the literature by combining the assessment of app feasibility with UTAUT. This study demonstrated that UTAUT can be used to model feasibility of app use in terms of acceptability, implementation, and practicality. This provides a framework for explaining barriers and supports to implementing app-based interventions that would be useful in future research exploring app use in interventions.

Limitations

This study was limited by a lack of a randomized design. The decision not to conduct a randomized-controlled trial was made by the research team based on the objective to assess feasibility. The app only being available on an Apple platform limited the number of people eligible to select the app. This represents a concern in any app-based intervention, as app availability and content may vary by platform. Another limitation was the small sample size. This is reflective of the lack of device ownership and interest in apps, as well as lower than expected enrollment in M4HH. Conducting research as part of an existing program was a limitation as additional time was required of both the participants and educators that was not required of all in attendance. Another limitation was that qualitative interviews were only conducted with the educators, and not the participants. A study which conducted interviews with both participants and educators on HTN app use found similar themes from both groups regarding app barriers.[28]

Comparison with Prior Work

Educating clients on interpretation of digital health and diet data has been identified as an area of increasing demand for Extension educators;[5] however, many barriers to this need have been identified in this study. A survey of British, Australian and New Zealand dietitians corroborates the finding that a lack of access to devices and the internet are concerns when incorporating apps into nutrition education.[29] The dietitian survey also found that nutrition professionals need more continuing education, with specific emphasis on how to incorporate apps into practice and the use of behavior change techniques in current apps.[29]

A failed trial aiming to use an app to improve HTN and diabetes management had contact with 90 potential participants, with only 22 agreeing to participant, and 15 downloading the app.[28] The lack of participation was attributed to lack of interest, time, and proficiency for app use, and the lack of devises required for app use. Another major concern was a lack of time on the part of the clinic staff to educate patients on app use. This study concluded that for effective use of mHealth to occur, a good fit between the selected app, the eHealth literacy of the users, recruitment efforts, treatment approach, and time and reimbursement for services would be necessary.

A study seeking to understand how to engage older adults with HTN and diabetes with a technology-based portal for self-care using UTAUT constructs as well as Technology Acceptance Model constructs.[15,30] found that the use of technology for health was associated with age, education, interest in apps or websites for health tracking and eHealth literacy.[30]

A conference paper examining the use of popular social networking apps in those over the age of 65 found that age related impairments and a lack of technology-based skills were barriers to app use.[31] While both those authors and the educators in this study indicated that

additional education is needed for older adults to use apps, the educators were also concerned that spending program time introducing the app may not feasible if not all participants were interested in or able to use the app.

Conclusions

As technology continues to evolve and people increasingly use apps for health guidance, providing recommendations of which apps to use and how to use them becomes more important. It has previously been noted that the increasing availability of information through technology has impacted the perceived value of Extension resources, and that Extension must adapt its methods accordingly.[27] However, at this time, the recommendation was that the app would be suited as a resource provided on the Extension website, or used to target younger audiences. A study of a web-based DASH intervention in younger (35.3 ± 8.1 years) African American women showed that technology-based interventions can be used to improve adherence to the DASH diet.[32] Future studies should examine the use of apps in educational interventions for preventing HTN in younger populations. To support app use in older populations, care should be taken to provide education to improve technology acceptance and to reduce barriers to implementing technology use.

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CHAPTER 6: SURVEY OF THE INCORPORATION OF APPS INTO HYPERTENSION CARE BY REGISTERED DIETITIAN NUTRITIONISTS

Introduction

Hypertension (HTN) represents a significant disease burden in the United States affecting 29.1% of U.S. adults over the age of 18 and increasing in prevalence as people age, impacting 65% of adults age 60 and over.[1] For adults diagnosed with HTN, only 51.9% have achieved good blood pressure control.[1] Dietary patterns have been shown to impact blood pressure, making dietary behavior change a strategy for managing HTN.[2–4] The degree to which changing eating behavior impacts HTN depends upon the level of adherence to behavior change strategies.[5]

Technology based health intervention show promise for the management of chronic diseases, and the increasing pervasiveness of mobile apps uniquely position them to support behavior change education by registered dietitian nutritionists (RDN).[6,7] Apps have been shown to utilize strategies which support dietary adherence for the management of HTN such as self-monitoring.[8]

A survey of RDNs conducted in England, New Zealand, and Australia in 2015 and 2016 showed that 62% of RDNs use apps in practice, with MyFitnessPal being the most commonly utilized app.[9] A study in the United States examining app use by clinicians in diabetes care corroborated the result that MyFitnessPal is the most commonly used app.[10] A 2012 survey showed that 57.3% of RDNs in Canada had used an app in practice at the time.[11]

More evidence is needed to establish the role of apps in supporting dietary behavior change to manage HTN[12] and to specifically understand how RDNs are using apps in HTN care

This study aimed to classify the incorporation of apps into the dietary management of hypertension by RDNs.

Methods

Survey Development

Initial survey items assessing dietitians' current practices regarding apps in the management of HTN were developed from a previously validated survey of practitioners use of apps in diabetes care.[10] Cognitive interviewing with 5 registered dietitians utilizing an iterative process in 2 rounds were conducted to further test the validity of the modified survey.[13] Inclusion criteria were Registered Dietitian Nutritionists (RDN) with a minimum of 1 year of experience working with patients with heart disease in clinical, outpatient, and community settings. Data on participant demographics and work setting were assessed to understand the generalizability of the responses. Approval for exemption was obtained by the Institutional Review Board at the University of Illinois (Appendix I).

Cognitive interviews were conducted by phone, recorded, and responses were transcribed verbatim. The RDNs were provided with a link to access the survey online, and were emailed the survey as an attached document. Verbal probes were used to assess understanding of survey questions (Appendix G).[13] Verbal probing was selected over think-aloud methods in order to assess wording and comprehension of survey items.[14]

After the first round of cognitive interviews, responses were summarized by survey item in a spreadsheet. Analysis was conducted by item, as the survey item, not the RDN was the unit of analysis.[14] Two researchers classified RDN responses separately, then discussed any differences until reaching agreement. Survey items were retained without modification when no

RDNs identified an issue with an item and when interpretation of the item was the same across RDNs. When only 1 RDN identified a problem the research team discussed until reaching agreement. Items were revised when 2 or more RDNs identify a problem type. Items were deleted if problems could not be resolved through revision. After the first round of modifications, the process was repeated for all modified items.[13]

Survey Administration

Participants. The final survey was sent to the Sports, Cardiovascular, and Wellness Nutrition Dietetics Practice Group of the Academy of Nutrition and Dietetics (SCAN) electronic list serve and to an email list of 5000 randomly selected RDNs obtained from the Commission on Dietetic Registration (Appendix H). Inclusion criteria were RDNs with a minimum of 1 year of experience working with patients with heart disease in clinical, outpatient, and community settings. The Institutional Review Board at the University of Illinois approved this research (Appendix I).

Data analysis. Descriptive statistics described current practice regarding the incorporation of apps into HTN management, including frequency of app use, reasons for incorporating apps into HTN education, perceived barriers to app use, and level of satisfaction with the incorporation of apps into education for HTN self-management. Friedman tests with Bonferroni corrections for multiple tests were used for comparisons.

In addition to information on current practice, the survey asked RDNs which apps they recommend for management of HTN. The frequency of each app dietitians listed identified the top apps currently used by registered dietitians for HTN management.

Regression analysis assessed the impact of dietitian characteristics, including RDN age, level of education, and gender on the incorporation of apps into patient care. All statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS) for Windows, version 24 (IBM Corp).

Results

Survey Development

In the first round of cognitive interviewing, 5 RDNs evaluated 41 items. The RDNs were all females with an average age was 43 years (range 31-67), 15 years of experience working with heart disease (range 3.5-40), and 14.4 years of experience as RDNs (range 3-24).

Cognitive interviews resulted in the clarification of 11 items, changes to sub-options for 10 items, changing responses options for 5 items, and response order for 1 item. Two items were removed, 2 items were divided into 2 questions each, 2 items were combined to 1 item on 2 occasions, and an option to comment was added to 1 item. Seventeen items were not modified. After the first round modifications the survey consisted of 40 items.

In the second round of cognitive interviewing, the same 5 RDNs evaluated the modified survey. This resulted in further clarification of 8 items, changes to sub-options for 3 items, changing response options for 1 item, and expanding response options for 2 items. Twenty-eight items were not modified.

Dietitian Survey-Administration

Participants. A total of 5,589 recruitment messages were sent to potential participants using 2 methods. A list serve message requesting participation was sent to the Cardiovascular

and Wellness sub-group of the Sports, Cardiovascular, and Wellness Nutrition Dietetics Practice Group of the Academy of Nutrition and Dietetics (SCAN) electronically. This group had 639 members on August 30, 2017, the day the message was sent. An email was sent on July 31, 2017 to a random set of 5000 dietitian emails acquired from the Commission on Dietetics Registration, with error messages received for 50 of these emails. A total of 280 RDNs responded to the survey for a response rate of 5%. This is similar to the response rate for a survey on the use of health apps in dietetic practice in Britain, Australia, and New Zealand.[9] Of the 280 RDNs initially responding to recruitment, 190 completed the survey. Reasons for non-completion are documented in Figure 6.1.

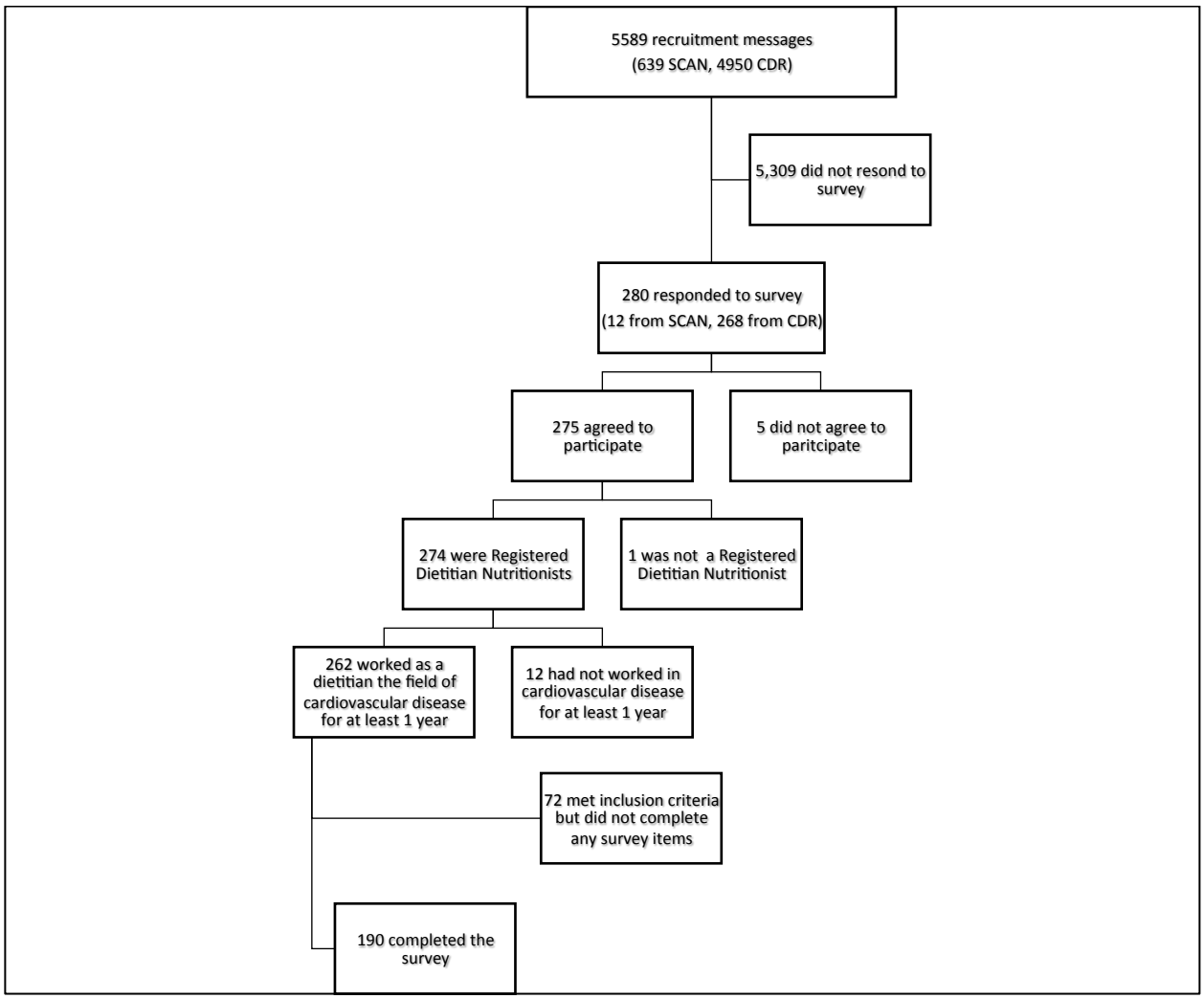


Figure 6.1. Survey recruitment and participation.

Participants were predominately female (180/190, 95%), non-Hispanic or Latino (179/190, 94%) and white (171/190, 90%). Demographic data of those completing the survey are shown in Table 6.1. The RDNs were from 38 different states and were licensed to practice in 40 states (Figure 6.2).

Table 6.1. Demographics of dietitians who completed the hypertension and apps survey (n=190).

		n (%)
Sex	Male	6 (3.2%)
	Female	180 (94.7%)
	Prefer not to answer	1 (0.5%)
	No response	3 (1.6%
Ethnicity	Not Hispanic or Latino	179 (94.2%)
	Hispanic or Latino	7 (3.7%)
	No response	4 (2.1%)
Race	American Indian or Alaska Native	0
	Asian	9 (4.7%)
	Black or African American	6 (3.2%)
	Native Hawaiian or Other Pacific Islander	0
	White	171 (90%)
Age group	20-29	13 (6.8%)
	30-39	84 (44.2%)
	40-49	31 (16.3%)
	50-59	38 (20%)
	60-69	21 (11.1%)
	No response	3 (1.6%)
Highest level of education	4 year degree	83 (43.7%)
	Master's degree	98 (51.6%)
	Doctoral degree	3 (1.6%)
	Professional degree (JD, MD)	3 (1.6%)
	Other	3 (1.6%)
	Missing	3 (1.6%)

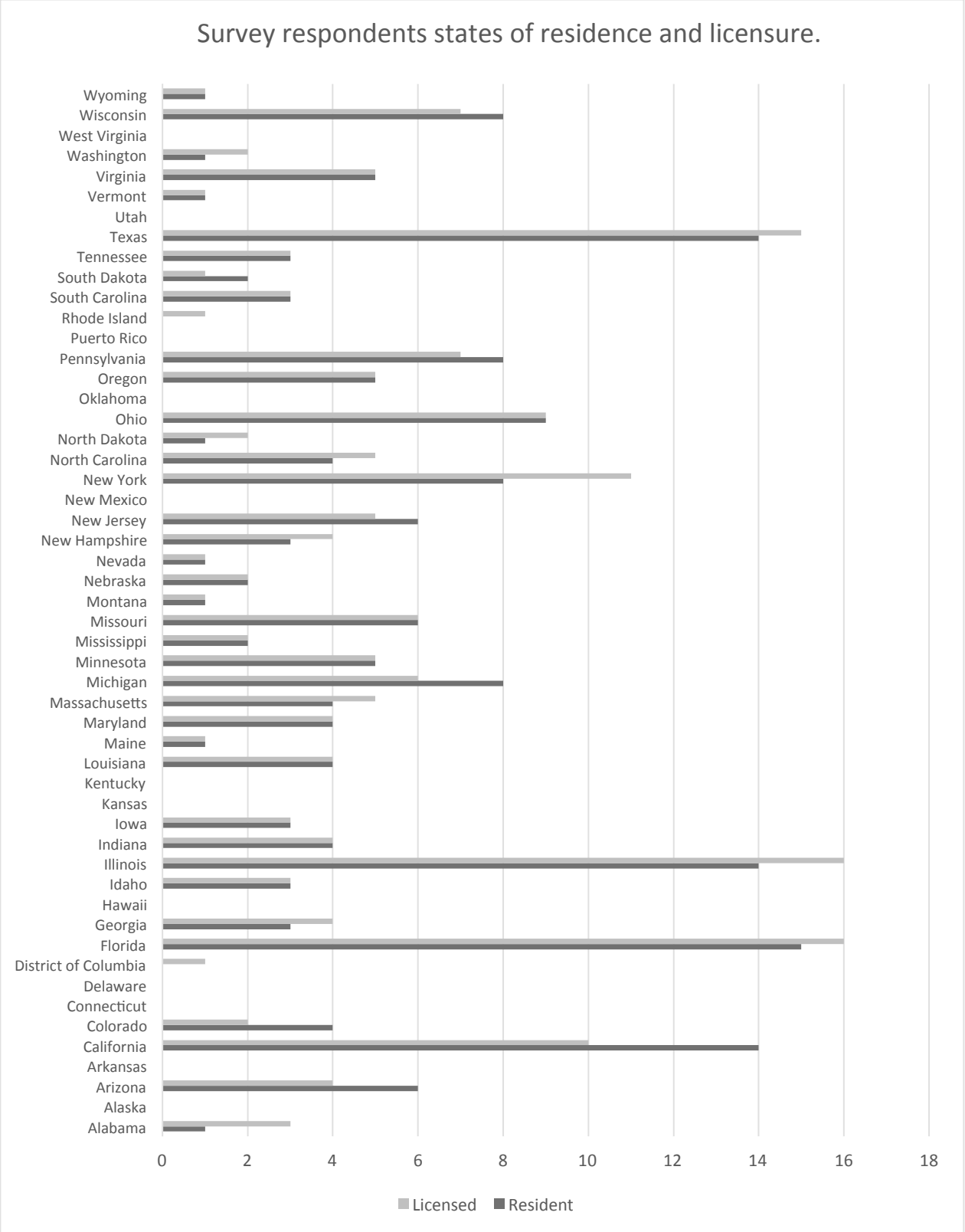


Figure 6.2. Survey respondents' states of residence and licensure.1

The RDNs represented a variety of practice settings, the most common of which were inpatient care (112/190, 58%), outpatient or ambulatory care (94/190, 49.5%), and community/outreach (25/190, 13.2%). The RDNs represented all career stages, and some had additional credentials and training beyond that required for RDNs (Table 6.2). The dietitians also reported on various conditions that they work with patients to manage (Figure 6.3).

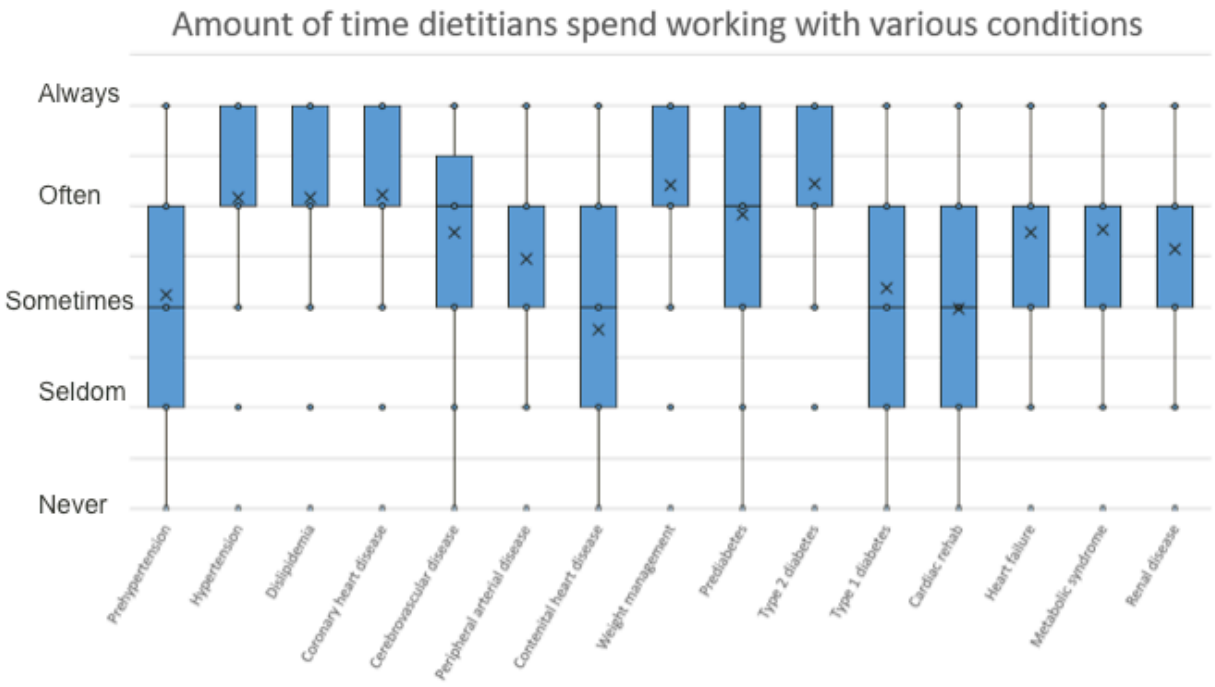


Figure 6.3 Percent of dietitians surveyed who work with patients with various conditions**.** [1]

Table 6.2. Credentials and work settings of dietitians who completed the hypertension and apps survey (n=190).

		n (%)
Credentials	RD/RDN	186 (97.9%)
	RN	1 (0.5%)
	CDE	24 (12.6%)
	BC-ADM	1 (0.5%)
	PharmD	1 (0.5%)
	Other (IBCLC, CSO, LDN, CPT, CSR, 4 CNSC, CSSD, expired CDE, CSOWM, 4 Graduate degree or licensure listed)	15 (7.9%)
Advanced training	Certificate of Training in Adult Weight Management	45(23.7%)
	Certificate of Training in Pediatric and Adolescent Weight Management	11 (5.8%)
	Board Certified Specialist in Pediatric Nutrition	3 (1.6%)
	Board Certified Specialist in Oncology Nutrition	3 (1.6%)
	Board Certified Specialist in Gerontological Nutrition	3 (1.6%)
	Board Certified Specialist in Sports Nutrition	3 (1.6%)
	Board Certified Specialist in Renal Nutrition	2 (1.1%)
	Other[1]	38 (20%)
	No advanced training	77 (40.5%)
Career stage	Early career (<10 years)	53 (27.9%)
	Mid-career (10-20 years)	74 (38.9%)
	Late career (>20 years)	57 (30%)
	Retired with connection to profession	2 (1.1%)
	No response	4 (2.1%)
Practice setting	Inpatient	112 (58%)
	Outpatient or ambulatory care	94 (49.5%)
	Community/outreach	25 (13.2%)
	Food service	10 (5.3%)
	Private practice	19 (10%)
	Corporate wellness	9 (4.7%)
	Home care	7 (3.7%)
	Grocery stores	2 (1.1%)
	Research	5 (2.6%)
	Education	11 (5.8%)
	Public health	7 (3.7%)
	Other[2]	17 (8.9%)
Hours per week in patient care	Zero	5 (2.6%)
	1-10	23 (12.1%)
	11-20	35 (18.4%)
	21-30	33 (17.4%)
	30-40+	86 (45.3%)
	No response	8 (4.2%)

[1]ACE Certified Health Coach, ACSM Certified Exercise Physiologist, Advanced Practice Certification in Clinical Nutrition, 2 Board Certified Specialist in Obesity and Weight Management, 9 Certified Diabetes Educator, Certified LEAP Therapist, 17 Certified Nutrition Support Clinician, CNSD, Marriage and Family Therapist, Master's Degree in Progress, Pharmacist

[2]Organizational development, telehealth, PACE program, between jobs-typically inpatient, cardio-pulmonary rehab, behavioral health, adults with ID/DD, long term care/rehab & private health coach, long term care, PMIC, outpatient public health clinic, hospice, not practicing as an RD, skilled nursing, wellness at a fitness center, cardiac rehab only, retired from 10 years in cardiac rehab

Data analysis. Survey items assessed RDN use of various devices in professional and personal settings (Figure 6.4). The RDNs were more likely to use a desktop or laptop (p<.001), a body weight scale (p=.001), and a glucometer (p<.001) in professional settings, while they were more likely to use mobile devices such as iPads or tablets, smartphones, and wearables (all p<.001) in personal settings (Table 6.3).

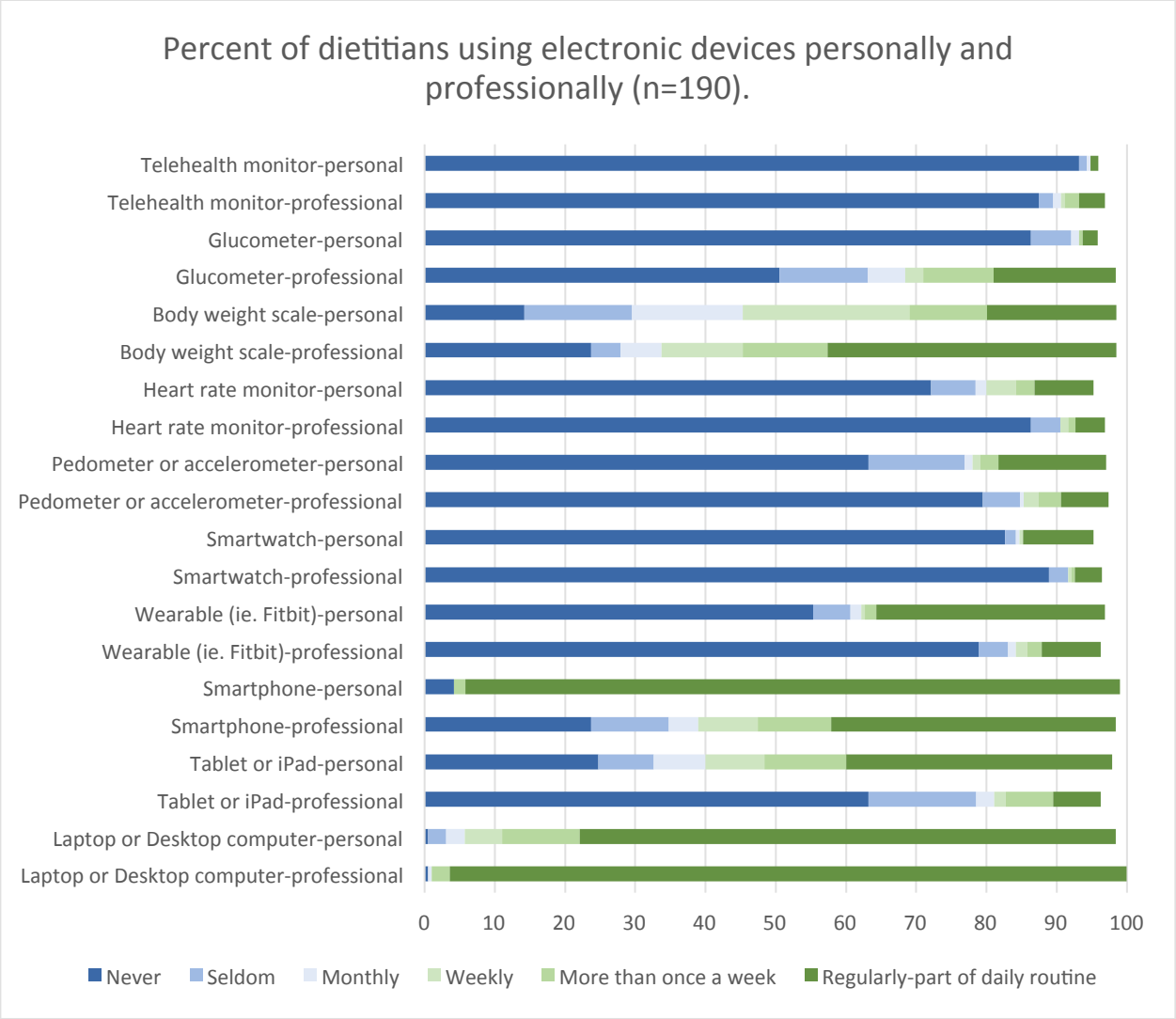


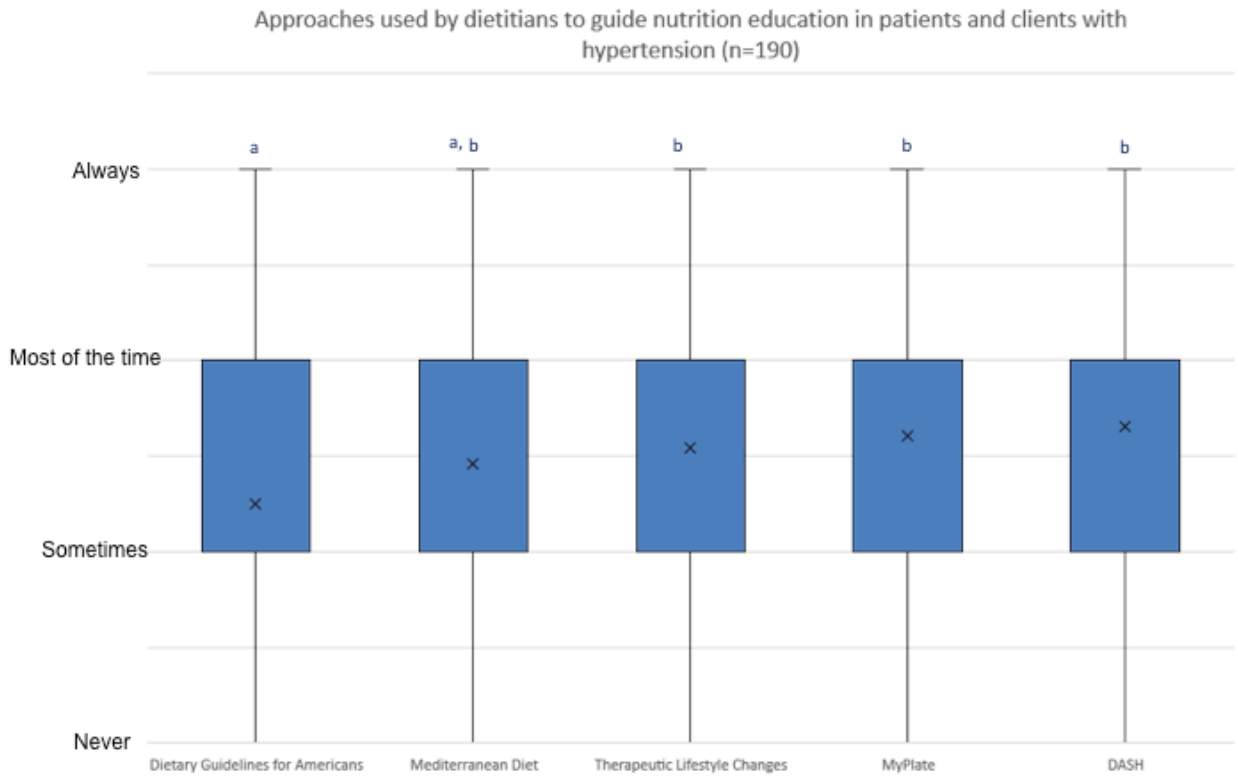
Figure 6.4. Percent of dietitians using electronic devices personally and professionally.

Table 6.3. Dietitians' use of electronic devices in work/professional settings compared to home/personal use.

	Dietitians who report device use more frequently at:				
	Work	Home	Same for both	*z*	*p*-value
Laptop or Desktop computer[1]	37	3	147	-5.22	<.001
Tablet or iPad[1]	11	113	57	9.07	<.001
Smartphone[1]	4	102	79	9.42	<.001
Wearable (ie. Fitbit)[1]	5	59	117	6.63	<.001
Smartwatch[1]	6	16	158	1.92	.06
Pedometer or accelerometer[1]	12	44	125	4.14	<.001
Heart rate monitor[1]	12	35	133	3.21	.001
Body weight scale[1]	87	48	51	-3.27	.001
Glucometer[1]	82	5	95	-8.15	<.001
Telehealth monitor[2]	1	16	164	-3.40	<.001

[1]Related samples sign test, asymptotic significance (2-sided test)
[2]Related samples sign test, exact significance (2-sided test)

Before analyzing the use of apps in HTN care, RDNs were asked what approaches they rely on when working with patients with HTN (Figure 6.5). A Friedman test was run to determine if there were differences in the approaches used by dietitians to educate patients with hypertension, excluding the selection other. Pairwise comparisons were completed with a Bonferroni correction for multiple comparisons. Educational approach differed significantly (χ^2_4=34.6, p<.001). *Post hoc* analysis revealed the Dietary Guidelines for Americans[15] was used significantly less than the Therapeutic Lifestyle Changes[16] (p=.045), MyPlate[17] (p=.001), and DASH[3,4] (p<.001). No significant differences were found between other combinations of approaches. Other approaches included, a plant based approach (n=5), a renal diet (n=3), a low sodium or 2 gram sodium diet (n=3), a low or controlled carbohydrate diet (n=3), a diabetes diet (n=3), the Academy of Nutrition and Dietetics or the nutrition care manual (n=3), the ADA plate or standards of care (n=2), the American Heart Association (n=2), the MIND diet (n=1), eat the rainbow (n=1), behavior modification (n=1), Dr. Ornish (n=1), food labels (n=1), intuitive eating (n=1), native lifestyle balance (n=1), and social cognitive theory (n=1).



TLC-DGA p=.045, MyPlate-DGA p=.001, DASH-DGA p<.001

Figure 6.5. **Percent of dietitians who used the following approaches to guide nutrition education for patients and clients with hypertension.**

RDNs were asked if they share app resources for the prevention or management of HTN. Responses varied, 36.3% (69/190) reported that yes, they share app resources, another 34.2% (65/190) reported sharing health app resources sometimes, and 29.5% (56/190) reported that they do not share health app resources. The RDNs were also asked how many of their patients they recommend health apps to, with 3.7% (7/190) reporting none, 15.8% (30/190) indicating few, 40% (76/190) indicating some, 25.3% (48/190) indicating most, 2.1% (4/190) indicating all, and 11.6% (22/190) reporting that they do not recommend apps (Figure 6.6)

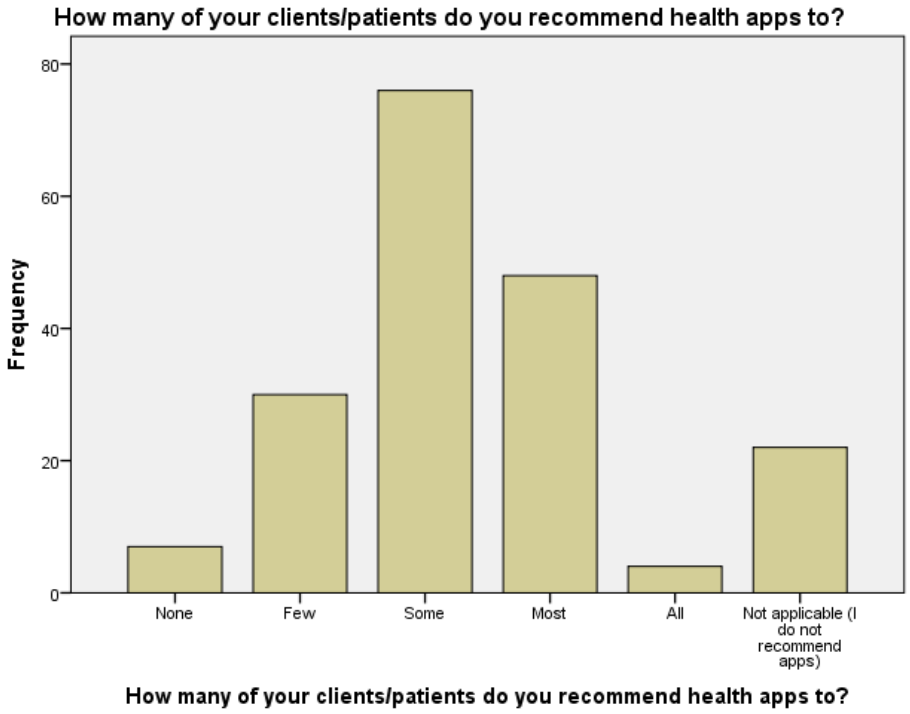


Figure 6.6. Frequency of health app recommendation by dietitians.

The RDNs were asked specifically about the use of apps for diet tracking. First, RDNs reported on their use of diet tracking as a strategy in general. Only 5% of RDNs (10/169) reported that they never ask patients to self-monitor through diet tracking, and 8.4% (16/190) reported only occasionally asking patients to self-monitor through diet tracking. The rest reported sometimes (33.2%, 63/190), most of the time (36.8%, 70/190), or always (16.3%, 31/190) asking patients and clients to self-monitor through diet tracking. In contrast, 16.8% (32/189) and 15.8% (30/189) never or occasionally evaluate patients' tracking logs respectively, 22.1% (42/189) sometimes evaluate logs, 17.9% (34/189) evaluate logs most of the time, and 26.8% (51/189) always evaluate patients' tracking logs. Next, a Friedman test was run to identify differences in diet tracking tools recommended by dietitians with pairwise comparisons performed with a Bonferroni correction for multiple comparisons. Tracking tool

recommendations differed significantly (χ^2_3=130.7, *P*<.001). Dietitians' median responses on a scale of 0-4 with 0 indicating the tool was never recommended and 4 indicating the tool was always recommended indicated that apps were used most of the time (3), pen and paper or an online program or website were used about half the time (2), and computer based word processing was sometimes used (1). *Post hoc* analysis revealed computer-based word processing was used significantly less than all other methods (all *P*<.001). Apps were recommended significantly more often than online programs or websites (*P*=.01). Significant differences were not found between pen and paper and online programs or between pen and paper and apps. Dietitians who recommended other methods of diet tracking reported that they use smartphone pictures (n=3), carbohydrate counting (n=1), pictures with tally marks for patients with low literacy (n=1), a spreadsheet created by the dietitian (n=1), suggests multiple options (n=1), and other than MyPlate super tracker not knowing enough about different programs and apps to recommend, but that patients sometimes have found resources on their own (n=1).

When asked reasons for recommending health-related apps to patients and clients with hypertension, most reported somewhat or strongly agreeing with the reasons for recommending apps (Figure 6.7). For all but 1 reason, between 12.6 and 17.9% (n=190) stated that they do not recommend smartphone apps to track that aspect of health; however, for helping patients better manage medications, 47.9% reported that they do not use smartphones to track this aspect of health. When asked to list other reasons for recommending apps, RDNS reported that their patients are elderly and do not use apps or do not have smartphones (n=3), patients are resistant to apps (n=1), pen and paper is powerful (n=1), there is a need for a fluid tracker app (n=1). A final dietitian reported that reasons for recommending apps are dependent on the patient and their personal needs, and this makes it difficult to make blanket statement

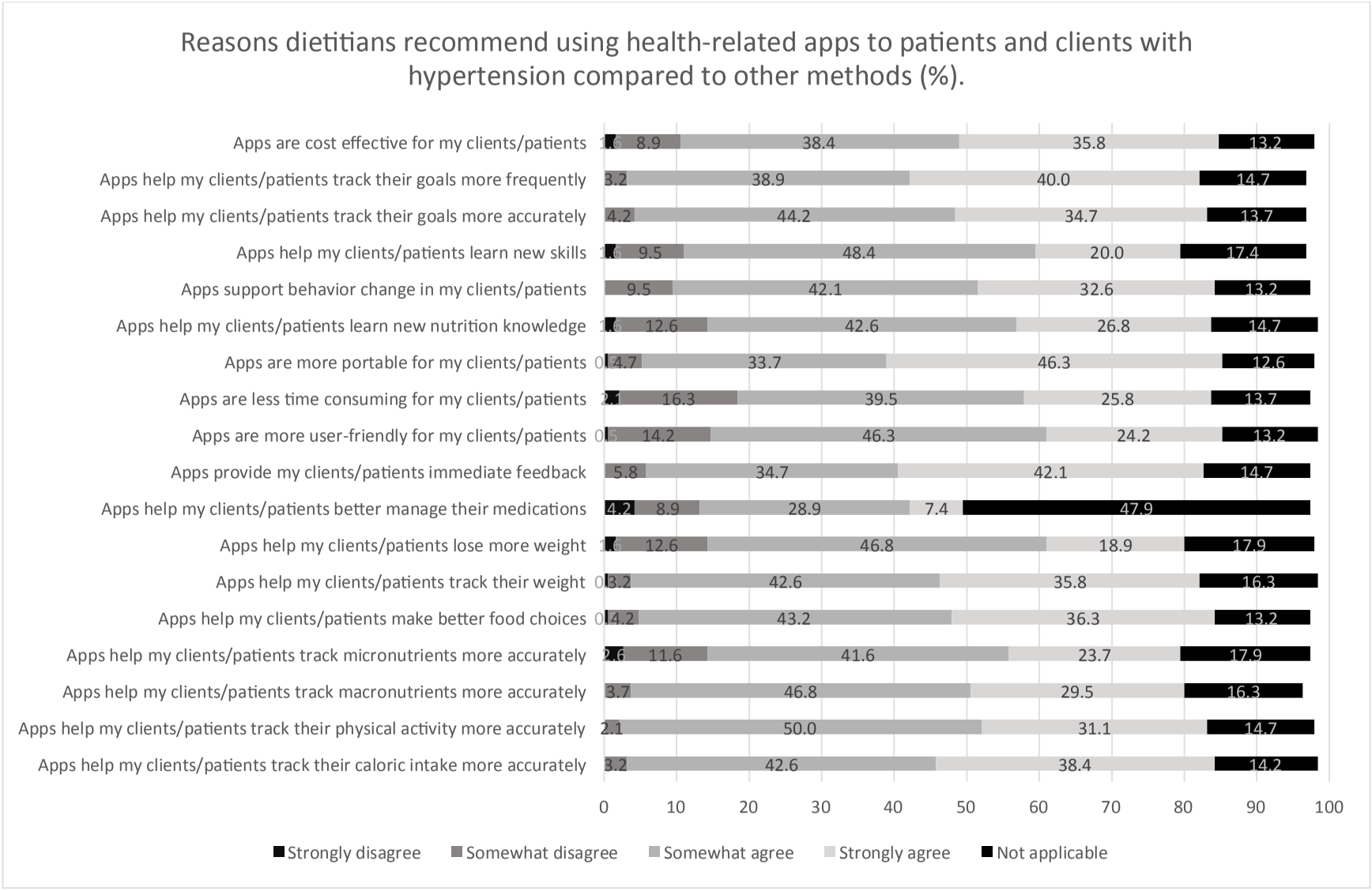


Figure 6.7. Reasons dietitians recommend using health-related apps to patients and clients with hypertension compared to other methods.

Dietitians were also asked how effective they felt smartphone apps are in assisting them in the assessment of various health-related behaviors on a scale of 0-4 with 0 indicating very ineffective and 4 indicating very effective (Figure 6.8). A Friedman test was run using data from a subset of the respondents who reported using smartphones for all of the surveyed health-related behaviors (n=75) to determine differences in RDNs' perception of the effectiveness of apps for assessing different health behaviors. Statistically significant differences were found (χ^2_6=118.9, *P*<.001). *Post hoc* comparisons with Bonferroni adjustments for multiple corrections showed statistically significant differences between dietitians rating of the effectiveness of using apps to assess health behaviors related to medications (median=2) compared to assessing health behaviors related to dietary intake (median=3, *p*<.001), health goals (median=3, *p*=.01), weight (median=3, *p*<.001), and physical activity (median=3, *p*<.001). Differences were also found between assessment of health-related behaviors concerning blood pressure (median=2) compared to dietary intake (median=3, *p*<.001), health goals (median=3, *p*=.002), weight (median=3, *p*<.001), and physical activity (median=3, *p*<.001). No differences were found between assessment of blood glucose and any of the other combinations of health related behaviors.

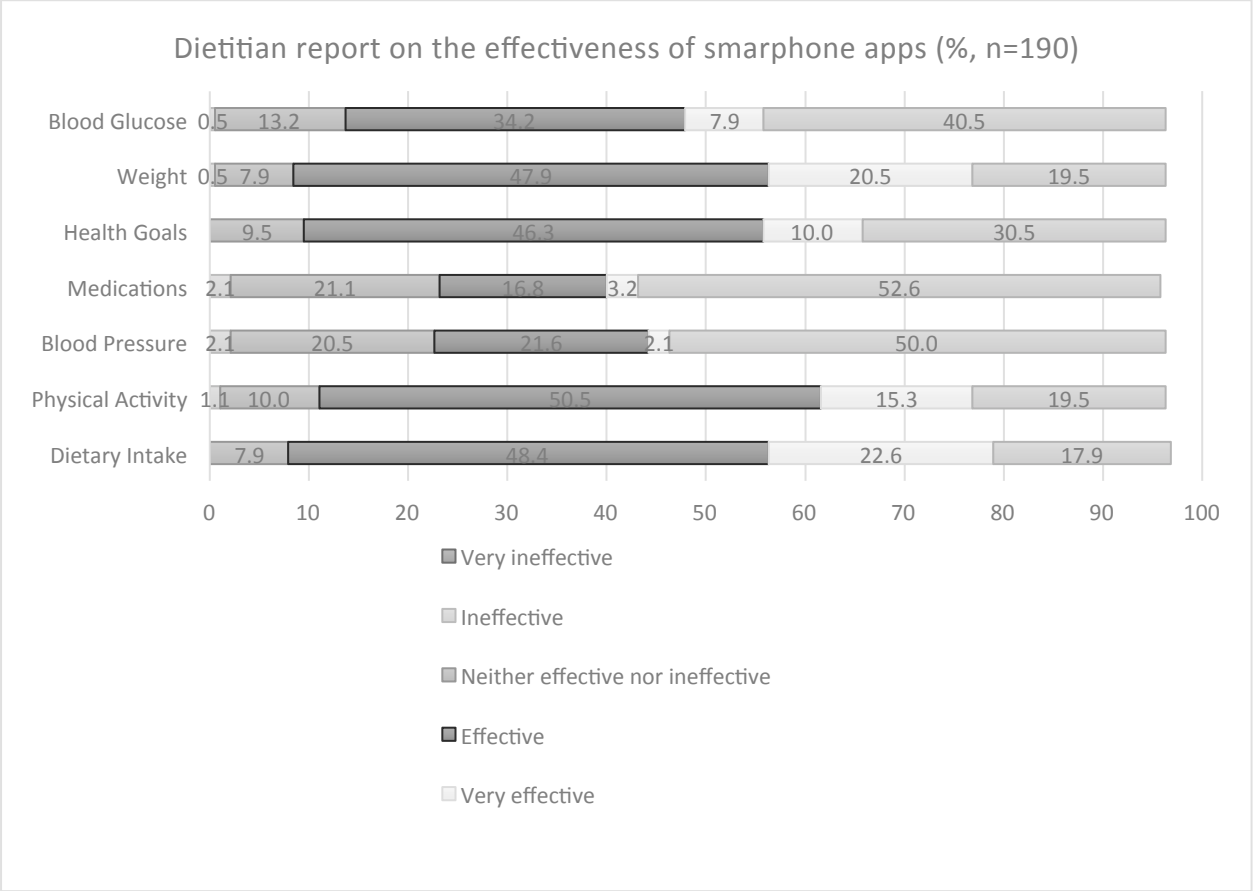


Figure 6.8. Dietitian report on the effectiveness of smartphone apps.

Dietitians were asked how likely they were to use various sources to find out about the apps that they use with patients on a scale of 0 to 4 with 0 representing highly unlikely and 4 representing highly likely. First, analysis was run to look at differences in the people that dietitians look to for information on apps. A Friedman test was run to determine differences in dietitians' likelihood of relying on various people for recommendations. Statistically significant differences were found (χ^2_3=225.2, P<.001). *Post hoc* comparisons with Bonferroni correction for multiple corrections showed significant differences between relying on a coworker or colleague (median=3) and relying on a client or patient (median =3, p=.004) with mean differences showing dietitians to be more likely to rely on a colleague or coworker (mean=3.21, SD=.93) than a client or patient (mean=2.86, SD=1.01). Dietitians were significantly less likely

to rely on a family member (median=2), or a friend (median=2) when compared to either coworkers or patients (all $p<.001$). No significant differences were found between friends and family members. Next, comparisons were made between other types of sources, finding that dietitians varied in their use of sources for finding out about apps ($\chi^2_6=388.8$, $P<.001$). *Post hoc* comparisons with Bonferroni correction for multiple corrections were used to assess pairwise comparisons. For app store searching, listserve/electronic mailing lists, and advertisements, medians response was 2. For Internet search, peer-reviewed journals, professional publications, and professional association websites, median response was 3. Significant differences were found between all combinations at $p<.001$ except for between advertisements and app store search which was significant at $p=.01$, and between app store and internet search, and app store and electronic mailing lists, both of which were not significantly different.

Items assessed RDN satisfaction and confidence with apps. The most common response to satisfaction to current apps for HTN management was neither satisfied nor dissatisfied with apps available for HTN (115/190, 60.5%), while 2.1% (4/190) were extremely satisfied (Figure x). The rest were somewhat satisfied (56/190, 29.5%) or did not respond (10/190, 5.3%). As for RDN confidence in their own ability to use apps, 47.4 % were very confident (90/190), 34.2% (65/190) were somewhat confident, 13.7% were uncertain (26/190) and 2.6% were very uncertain (5/190) (Figure 6.8).

Figure 6.9. Dietitian satisfaction with apps available for management of hypertension.

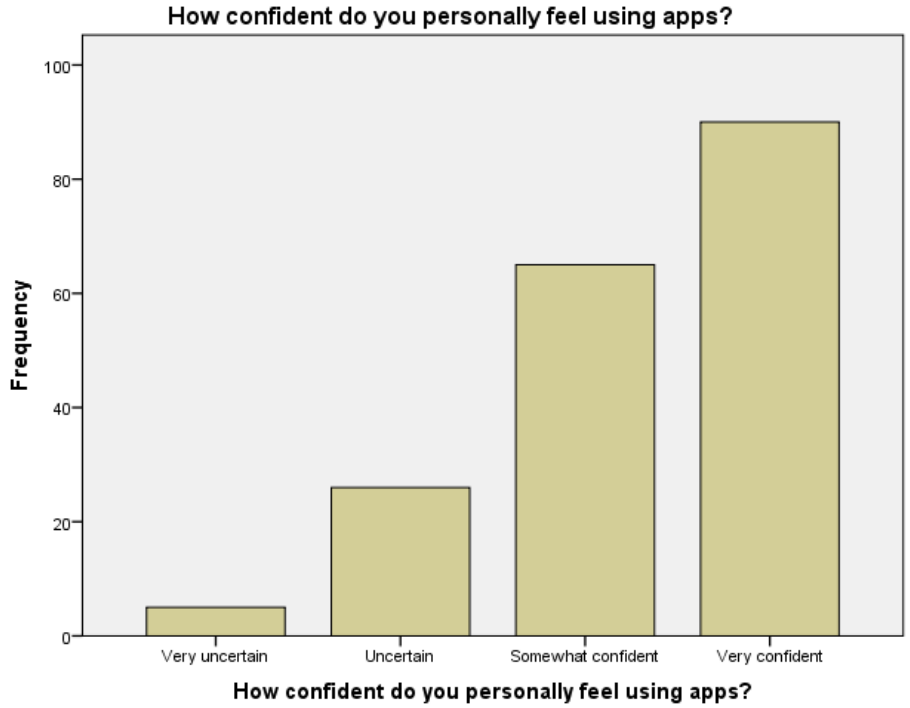


Figure 6.10. Dietitian confidence with personal use of apps.

Dietitians were asked to indicate what proportion of their clients would be able to use apps based on age group. For children less than or equal to 10 years, 72.6% (139/190) reported that they do not work with this age group, and for 11-18 years 55.3% (105/190) did not work with that age group. For adults RDNs reported not working with age groups were 10.5% (20/190) of 19-29 year olds, 4.7% (9/190) of 30-49, 1.1% (2/190) of 50-64, 0.5% (1/190) of 65-75, and 2.6% (5/190) for greater than 75 years. A Friedman test was run to determine differences in the proportion of patients that would be able to use health apps in the adult age groups. Statistically significant differences were found (χ^2_4=466.4, P<.001). *Post hoc* analysis with Bonferroni correction for multiple corrections showed significant differences between all adult age groups (Figure 6.11). Significance values between 65 to 75 and 75 plus were p=.001, all others comparisons were p<.001. Median responses were that 80-100% of 19 to 29 and 30-49 year olds would be able to use health apps, decreasing to 40-59% of 50-64 year olds, 20-39% of 65-75 year olds and <20% of those older than 75.

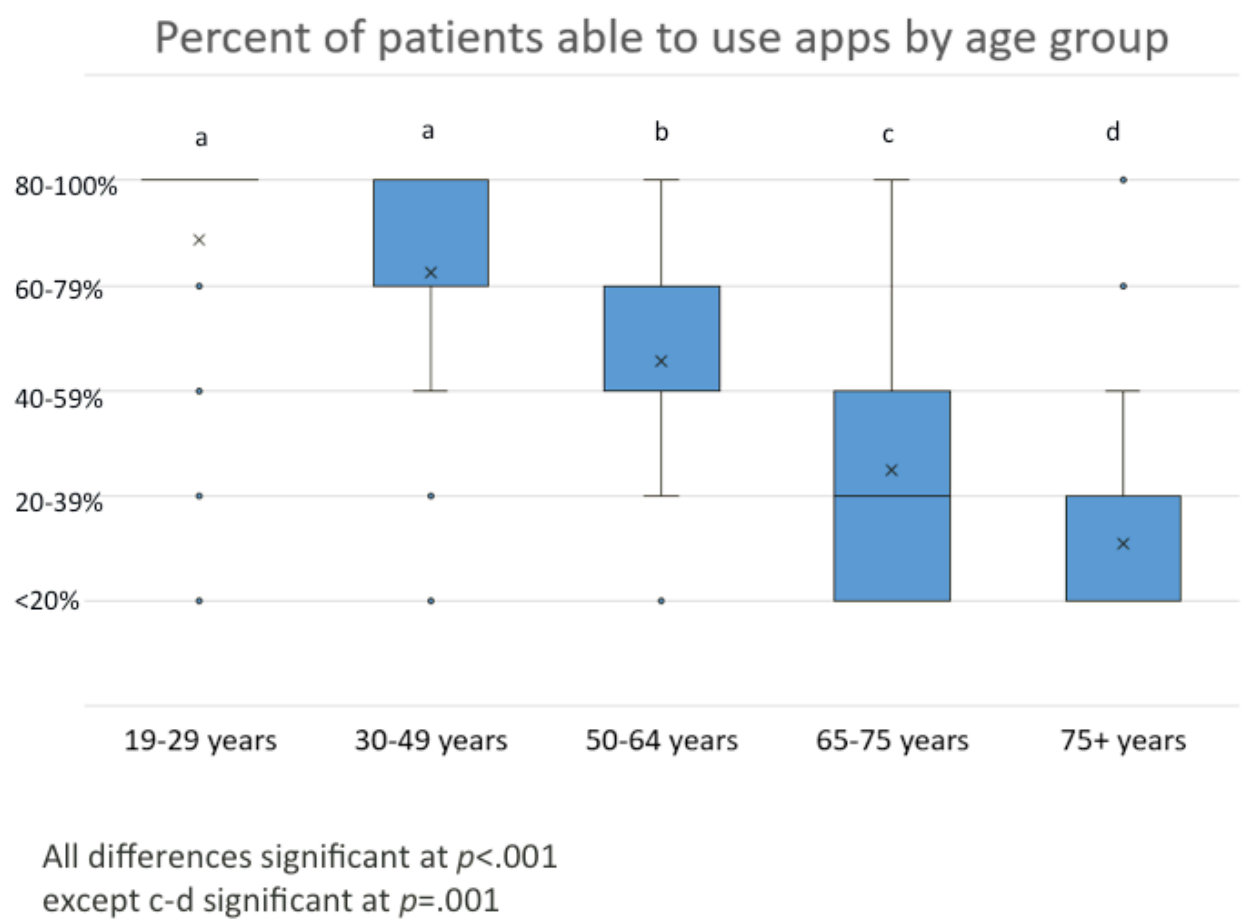


Figure 6.11. Percent of patients able to use apps by age group.

When asked to rate items that dietitians consider when recommending apps on a scale of 0 to 4 with 0 indicating very unimportant and 4 indicating very important, RDNs mean response for considering if patients were already using apps (3.6, SD 0.7), using health apps (3.2, SD 0.9), if patients had access to a smartphone or tablet (3.8, SD 0.5), literacy (3.4, SD 0.7), health literacy (3.4, SD 0.7), and language preference (3.2, SD 0.8) were all important to very important.

When asked what barriers RDNs have found using health apps personally, a number of themes emerged. These included concerns with the accuracy and reliability of the information

within apps (n=15), difficulties when foods consumed were not included in the app (n=11), motivation to continue using the app (n=23), concerns with the time it would take to use an app (n=36) and feeling that apps are not user friendly (n=16). Some expressed a lack of desire to use apps (n=15), while others said they had never used an app (n=9). Some expressed concerns based on the technology to support apps (n=6), including not having a phone, internet access, or enough storage to support apps. Similar concerns were expressed when RDNs were asked what barriers their patients encounter with apps, including concerns with accuracy (n=7), foods not included in the apps (n=4), motivation to start or continue using an app (n=31), time (n=22), user friendliness (n=22), lack of technology needed to support apps (n=14). Additional barriers that RDNs did not list for themselves, but did for their patients included concerns with the age related concerns (n=24), concerns that patients were not tech savvy and lacked experience with app technology (n=32), cost (n=9) and literacy (n=3).

Dietitians were asked what apps they encourage patients with HTN to use. For comparison, they were also asked which apps encourage patients to use for weight management. For weight management 63.5% (108/170) dietitians encouraged MyFitnessPal with 54.7% (93/170) listing MyFitnessPal as their only or most preferred app and another 9.8% (15/170 listing MyFitnessPal as one of the apps they recommend. The next most common response was none (38/170, 22.4%), followed by 5.3% (9/170) listing LoseIt as the most preferred app and 4.7% (8/170) listing FitBit first. For HTN the most common response was none (108/169, 63.9%). The next most common response was the list MyFitnessPal as the only or top app (23.1%, 39/169) all other apps were only listed first by 1 or 2 dietitians. When comparing responses between weight management and HTN apps, almost half (44.9%, 79/176) responded

the same way, either recommending the same app(s) (n=42) for both hypertension and weight management, or no app (n=37) for either.

Stepwise regression analysis showed that as education level increased, the number of patients that RDNs recommend apps to also increases (R^2=.04, p=.01). Age and gender were not significant predictors of app recommendations.

Discussion

Principle Findings

Dietitians rely on various dietary approaches for the management of hypertension, including Therapeutic Lifestyle Changes,[16] MyPlate,[17] and DASH.[3] While no statistically significant differences were found between use these 3 approaches, Therapeutic Lifestyle Changes (p=.045), MyPlate (p=.001), and DASH 3 (p<.001) were each used significantly more often than the Dietary Guidelines for Americans.[15] The same RDNs reported that they always (16%), most of the time (37%), or sometimes (33%) use diet tracking as a strategy, with only 5% and 8% never or only occasionally using diet tracking respectively. When comparing tracking methods, median responses indicated that RDNs use apps most of the time, pen and paper or online programs about half the time, and computer based word processing sometimes.

Forty-one percent of RDNs reported using smartphones as part of their daily professional routines, and 36% reported that they share app resources with patients and clients. Satisfaction with apps was for HTN was indecisive as 61% OF RDNs reported that they were neither satisfied nor dissatisfied with the apps available for HTN, 30% were satisfied, and only 2% were extremely satisfied. This was reflected by RDN response to their most preferred app for HTN as, the most common response was that they did not have a preferred app for HTN (64%). For those

who did recommend apps for HTN, MyFitnessPal was the most common app. MyFitnessPal is not specific to HTN, but is a diet tracking app.

Major barriers RDNs perceive to using apps with patients with HTN include the age and technology experience of the participants. This was supported by RDNs' assessment that a lower proportion of older patients are able to use apps compared to younger patients. Other barriers to app use included concerns with the accuracy and user friendliness of apps.

While RDNs use apps during the professional day (41%), share app resources (36%), and ask clients to track diet (n=101), they do not recommend an app specifically for HTN and are ambivalent about current apps for HTN.

Limitations

The low response rate in this study was a limitation. However, this response rate is consistent with other evaluations of RDN app use.[9,11] Another limitation was that only RDNs were surveyed, preventing analysis of actual app use by patients with HTN.

Comparison with Other Work

Smartphone and app use for nutrition care varies across surveys. One study has higher rates of mobile device use among Canadian dietitians (69%) than was found in the current study, but also reported that survey respondents were relatively young.[1] Another survey reported that 1 in 2 British dietitians use apps in practice.[9] While these 2 studies examined mobile device and app use in general nutrition practice, a survey of sports dietitians from 5 countries found that 32% use apps to assess and track diet.[18] This is more consistent with the current study, which also focuses on a specific target of nutrition education.

Diet tracking is a common strategy used within health apps. One study showed that 72.6% (n=234) of apps from credible health organizations included a tracker.[19] Another found that tracking diet and physical activity were among the most common reasons for health app use.[20] The most frequently identified app in this study was a diet tracking app, MyFitnessPal. The identification of MyFitnessPal as the most frequently recommended app is consistent with a survey of app use in diabetes care in the United States[10] and in a survey of dietitian app use in England, Australia, and New Zealand[9] and a survey of sports dietitians in Australia, Canada, New Zealand, the United Kingdom, and the United States.[18]

This study found that apps are used for diet tracking more often than online trackers, but not pen and paper. This is in contrast to a study that compared an app-based food diary to a web-based food diary and a traditional hand-written food diary. That study found significant differences in the frequency of using the app compared to paper diary and the web-based diary, but not the web-based and hand-written diary.[21]

Technology acceptance has been theorized in the Unified Theory of Acceptance and Use of Technology.[22] This theory includes constructs that predict intention to use technology and actual use of technology. Comparing these constructs to the data identified in this survey provides a framework for understanding RDN responses. Concerns with the accuracy of apps was consistent with the construct of performance expectancy, as was the assessment of RDN perspective on the effectiveness apps and importance of various features within apps. Items assessing confidence in using apps, and user friendliness of apps were consistent with the construct of effort expectancy. The construct of social influence was addressed by items examining who RDNs turn to in order to learn about apps. The concern that some patients may not own technology was in line with the construct of facilitating conditions, as were items

assessing patient access to devices, literacy, and health literacy. Age and previous experience with technology, moderating variables in the theory, were also covered by survey items. Many of the items addressed both RDN app experience and patient experience from the RDN perspective. Age was shown to be of significant concern to RDNs when using technology, as increasing patient age decreased RDN confidence in patients' ability to use health apps.

Future Directions

While health and nutrition apps are widely available, this study failed to identify an app specific to HTN that is regularly utilized by RDNs. Future studies should examine the efficacy of using MyFitnessPal to manage HTN. Research should also identify if an app specifically designed for managing HTN is available and would be beneficial to HTN treatment. RDNs also identified a number of barriers to utilizing apps in HTN management. Future research should identify if patients perceive the same barriers, and develop strategies for overcoming these barriers.

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CHAPTER 7: CONCLUSIONS AND FUTURE DIRECTIONS

Conclusions

The availability, usage, and content of mobile apps are complex. This research moved towards untangling the complexity of app use in nutrition interventions. A systematic review of apps for nutrition education indicated that few studies examine if apps improve knowledge and behavioral outcomes in nutrition interventions.[1] While the limited research identified pointed to the potential for apps to improve adherence to intervention, much work is needed to establish the efficacy of apps in nutrition interventions.

A concern of app use in nutrition practice is the quality of available apps in terms of content, functionality, and potential to support educational objectives. The app quality evaluation tool provides a reliable, quantitative method of assessing app quality.[2] This allows for objective means of selecting apps for use in nutrition education research and care.

In order to better unravel the complex topic of the availability, quality, and use of apps for chronic disease, this research sought to explore the role of apps in hypertension (HTN). In order to assess apps, rather than diet, the Dietary Approaches to Stop Hypertension (DASH) was selected as the target dietary approach as this diet is established as useful for hypertension control. A search for apps related to DASH revealed that few apps specific to DASH are available, a finding supported dietitian report that an app specific to HTN is not incorporated into regular care. By applying the app quality evaluation tool to assess the few available apps, one app was selected as having better quality than the others. The analysis also indicated that even the selected app had room for improvement to support behavior change.

To assess the feasibility of using an app for HTN care, the feasibility of adding the app to a community based heart disease intervention was assessed. Many feasibility concerns were identified related to the use of an app. Program participants had low interest in using the app. The educators also indicated that the average participant in their community-based heart disease program has limited experience using technology, and this to a large extent was due to participant age. The educators felt that they needed additional training to be able to incorporate apps into programing, and that their participants would need additional education on the use of apps as well.

In practice, apps are commonly used as diet trackers with most dietitians who use apps relying on MyFitnessPal. Dietitians are not routinely using an app specific to HTN, as the most commonly used app for HTN is MyFitnessPal. However, many dietitians do not use any app with patients with HTN.

The usage of apps in nutrition interventions remains a complex topic. While this work lays a foundation for evaluating app content and use in nutrition education, the variability of both available apps and those who use them confound the understanding of optimal app use. Apps have not been fully integrated into dietetic practice. Many complexities impact app use, including app platforms, devices, availability, and content meaning that further work is needed to establish the efficacy of app use in nutrition interventions.

Future Directions

Future research should seek to establish who would most benefit from app-based interventions. This research suggests that with increasing age, apps are less desired. This brings into question the usefulness of apps for chronic disease management as risk of chronic disease

increases with age; however, apps may play a role in prevention of chronic disease for younger populations. Future research should focus on determining if providing more education on how to use an app would be beneficial to older populations, and to establishing the role of apps in prevention of chronic disease with younger populations. Also, as chronic disease occurs more frequently in younger populations, and as younger generations age, the outlook on the use of apps in chronic disease may change.

The one app available for HTN management scored lower than desired for supporting behavior change. Future research in app development and use should seek to identify app features that support behavior change, such as goal setting, self-monitoring, and in providing tailored feedback. Although apps may be more accessible for individuals than paper and pen methods for self-monitoring, they might be just as, or more, time consuming. This should be explored to justify app usage in self-monitoring.

To better understand the evaluation of apps, trends in app quality evaluation (AQEL) scores should be studied to determine the typical variability of scores. While for this research quality cut points were hypothesized, future research should establish if those cut points accurately classify apps. Additional work should also be done to determine if a total AQEL score is possible and how to weight each sub-category score. This would allow a more streamlined method of evaluating and comparing apps for selection in nutrition interventions.

Nutrition educators in the feasibility trial and the dietitians in the survey of app practice indicated that additional training is needed to support app incorporation into nutrition care both in individual counseling and group classes. Future research should seek to identify training methodology to improve educator self-efficacy for app use. Additionally, other settings should be identified for app-based interventions. Possibilities include targeting clinic settings and

worksite wellness initiatives. Before these interventions are conducted, device ownership, and familiarity with the use of apps should be considered for both the study participants and the professional providing education.

At this time, apps may not be suited for nutrition education and care in the context of HTN beyond use as general diet and physical activity trackers. This is in part related to the lack of availability of HTN specific apps and the lack of app incorporation into regular practice. While apps may support adherence to interventions, many barriers have been identified to the use of apps. Going forward, these barriers need to be addressed in order to increase the usefulness of apps, first from the perspective of the professionals who recommend them, then to determine ways to optimize app implementation by those who will use them to modify nutrition behavior. Due to the complex nature of app content and use, much more work is needed to establish evidence-based practice for the effective use of apps in nutrition care.

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APPENDIX A: CHECKLIST FOR REPORTING RESULTS OF INTERNET E-SURVEYS (CHERRIES)

Checklist for Reporting Results of Internet E-Surveys (CHERRIES)

Design

The App Quality Evaluation (AQEL) was designed for use by nutrition researchers and registered dietitians when evaluating of apps. For validation, three populations were targeted: nutrition professionals, app developers, and app end users. For reliability testing, nutrition educators were targeted from the Nutrition Education for the Public Dietetics Practice Group of the Academy of Nutrition and Dietetics. All samples were convenience samples.

IRB (Institutional Review Board) approval and informed consent process

IRB approval was obtained before recruiting participants. Participants were recruited through email blast, where they were informed of the study purpose, investigator information, length of time participation would require, and data storage. After participants agreed to participate, the information was reiterated in an information letter sent via email attachment along with information on how to take the survey. Written consent was waived. Emails containing personal information were deleted, and all identifying data is stored on a password protected computer or in a locked filing cabinet in the in the principal investigators laboratory.

Development and pre-testing

This paper outlines survey development in the methods section. In the second round of face validation, and in reliability testing, the survey was tested in its electronic format.

Recruitment process and description of sample having access to the questionnaire

For validation, participants were contacted by direct email or by advertising in a weekly e-blast sent to university employees. For reliability testing, members of the Nutrition Education for the Public Dietetics Practice Group of the Academy of Nutrition and Dietetics were contacted through an electronic mailing list.

This was a closed survey. For the first round of validation, participants were sent the survey as a word document. For the second round of validation and for reliability testing, only participants who responded to the recruitment email were supplied with the access link. For reliability testing a unique code was given to each participant.

Survey administration

The survey was administered using Qualtrics, with a link to access the survey supplied by email. Participation was optional. Amazon gift cards were offered as incentives for survey completions. Data was collected over 2 months with participants completing the survey for 3 apps each on 2 occasions 1 month apart.

Adaptive questioning was used, with responses to some questions determining which questions were shown later in the survey. Fifty-one items distributed over 10 screens were included in the survey, with some items grouped as a series of sub-questions. Between 1 and 12 items were on a screen. Four screens

included 1 or 2 items, five screens included 6 to 8 items (two of these could be reduced by adaptive questioning), and one screen had 12 items.

Response rates

Twenty-nine people initially agreed to complete 3 app evaluations using the tool, 25 actually completed the evaluations (86%).

Preventing multiple entries from the same individual

Each participant was required to enter a unique code. If participants started a survey but did not finish, they were required to restart the entire survey. The completed survey was kept for analysis. Participants completed the survey for three apps on two occasions for each app in the first data set, and on one occasion on in the second data set. The user codes were used to assure responses were limited to this number.

Analysis

All participants finished the survey; however some items were skipped. Multiple imputations as described in the methods were used to handle missing data.

APPENDIX B: APP QUALITY EVALUATION (AQEL)

App Quality EvaL (AQEL)

For access to the online survey, information on how to score AQEL, as well as permission to use the questions, please contact Kristen DiFilippo at kdifilip@illinois.edu.*

App Information

Q1 **The first questions are to clearly identify which app is being evaluated.**

Q2 What is the name of the app you are evaluating?

Q3 What is the version number of the app (if the app has never been updated, please put Version 1)? You will find this when downloading the app.

- ○ Version (example: 1.2) _____
- ○ Not sure

Q4 Is this app the full app or a lite version of the app? You will find this when downloading the app, or on the app icon.

- ○ Full
- ○ Lite
- ○ Unsure/Not applicable

1

Q5 The most recent revision date (or date of creation if no revisions) is:

- ○ Within the last month
- ○ Within the last 6 months
- ○ Within the last year
- ○ Longer than one year
- ○ Date generated by application (does not apply to content)
- ○ Not applicable

Q6 What "store" did you use to download the app?

- ○ Google Play
- ○ iTunes
- ○ App Store
- ○ Other (please provide name of store) _____

End of Block

AQEL: User information

Q7 **This next set of questions is to gather user information about the app.** *Spend 10-15 minutes familiarizing yourself with and trying out all parts/features of the app. After using the app, please answer the rest of the questions. You may refer back to the app as you answer the questions.*

Q8 Please select the device(s) you used to evaluate the app (please check all that apply)

- ☐ iPad
- ☐ iPhone
- ☐ Kindle
- ☐ Android
- ☐ Other, please list _____

End of Block

AQEL: App Purpose

Q9 Do you feel that the app has a clear purpose?

- ○ Yes
- ○ Maybe
- ○ No

Q10 Does the app title accurately describe the content of the app?

- ○ Title describes the content very accurately
- ○ Title mostly describes the content accurately
- ○ Title is somewhat related to the content
- ○ Title is hardly related to the content
- ○ Title does not relate to the content in any way

End of Block

AQEL: Behavior change, knowledge and skill development

Q11 In your opinion does the app try to...

	Yes	No
increase knowledge?	○	○
develop a skill?	○	○
change behavior?	○	○

Q12 Do you think the app will...

	Definitely yes	Probably yes	Maybe	Probably not	Definitely not
increase the user's knowledge?	○	○	○	○	○
lead to the development of a skill?	○	○	○	○	○
lead to behavior change?	○	○	○	○	○

Q13 When considering activities within the app, please answer the following:

	Very likely	Likely	Somewhat likely	Unlikely	Very unlikely
Will the activities help the user to increase knowledge?	○	○	○	○	○
Will the activities help the user to change behavior?	○	○	○	○	○
Will the activities help the user to develop a skill?	○	○	○	○	○

Q14 Please answer the following questions:

	Definitely yes	Probably yes	Maybe	Probably not	Definitely not
Would your friends use this app?	○	○	○	○	○
Do you intend to use this app in the future?	○	○	○	○	○
Will you do something differently after using this app?	○	○	○	○	○
Will you try to do something new after using this app?	○	○	○	○	○

Q15 How well does the app provide:

	Very well	Well	Adequately	Poorly	Very poorly
Information?	○	○	○	○	○
Feedback on progress?	○	○	○	○	○
Timely feedback whenever needed?	○	○	○	○	○

Q16 Is feedback provided when the user participates in an activity in the app?

- ○ Yes
- ○ No
- ○ Not applicable

End of Block

AQEL: App functionality

Q17 Please rate the following:

	Very good	Good	Ok	Bad	Very bad
Speed of loading the app	○	○	○	○	○
The user's ability to "retrace their steps" if they need to	○	○	○	○	○
Transitions from page to page	○	○	○	○	○
Function of any animations (quick & functional - slow & fragmented)	○	○	○	○	○
Design of menus and icons	○	○	○	○	○
Ease of navigation to the app's various features	○	○	○	○	○

End of Block

AQEL: What app is for/Who app is for

Q18 **This set of questions refers to what the app is for, and who it is for.**

Q33 What age group is the app targeting? Please select all that apply

- ☐ Children
- ☐ Teenageers
- ☐ Adults
- ☐ General Audience (all of the above)
- ☐ Other (Please list) _____

Q19 Is the app appropriate for children in terms of

	Yes	Maybe	No
Maturity level	○	○	○
Nutrition needs	○	○	○
Cognitive abilities	○	○	○
Color scheme	○	○	○
Readability	○	○	○

Q37 Is the app appropriate for teenagers in terms of

	Yes	Maybe	No
Maturity level	○	○	○
Nutrition needs	○	○	○
Cognitive abilities	○	○	○
Color scheme	○	○	○
Readability	○	○	○

Q38 Is the app appropriate for adults in terms of

	Yes	Maybe	No
Maturity level	○	○	○
Nutrition needs	○	○	○
Cognitive abilities	○	○	○
Color scheme	○	○	○
Readability	○	○	○

Q39 Is the app appropriate for a general audience in terms of

	Yes	Maybe	No
Maturity level	○	○	○
Nutrition needs	○	○	○
Cognitive abilities	○	○	○
Color scheme	○	○	○
Readability	○	○	○

Q40 Is the app appropriate for the other age group you selected in terms of

	Yes	Maybe	No
Maturity level	○	○	○
Nutrition needs	○	○	○
Cognitive abilities	○	○	○
Color scheme	○	○	○
Readability	○	○	○

10

Q34 Who is the target audience of the app? Please select all that apply

- ☐ People seeking help for a medical condition such as diabetes, heart disease, eating disorders, or other medical conditions. (please list which condition the app is for, or list the other medical condition) _____
- ☐ People with specific nutrition concerns such as food allergies, sports nutrition, or other nutrition concerns. (please list which nutrition concern the app is for, or list the other nutrition concern) _____
- ☐ People who are shopping for food
- ☐ People seeking recipes/meal ideas
- ☐ People seeking guidance for restaurant eating
- ☐ People seeking weight loss support
- ☐ People seeking nutrition education (including nutrition education games)
- ☐ Other, (please list target audience) _____

Q20 When considering people seeking help for a medical condition

	Yes	Maybe	No
Is the app appropriate?	○	○	○
Does the app cover the topic comprehensively?	○	○	○
Does the app cover the medical condition as well as including related topics?	○	○	○
Is the level of detail provided adequate for this population's educational needs?	○	○	○

Q41 When considering people with specific nutrition concerns

	Yes	Maybe	No
Is the app appropriate?	○	○	○
Does the app cover the topic comprehensively?	○	○	○
Does the app cover the medical condition as well as including related topics?	○	○	○
Is the level of detail provided adequate for this population's educational needs?	○	○	○

Q42 When considering people who are shopping for food

	Yes	Maybe	No
Is the app appropriate?	○	○	○
Does the app cover the topic comprehensively?	○	○	○
Does the app cover the medical condition as well as including related topics?	○	○	○
Is the level of detail provided adequate for this population's educational needs?	○	○	○

Q43 When considering people seeking recipes/meal ideas

	Yes	Maybe	No
Is the app appropriate?	○	○	○
Does the app cover the topic comprehensively?	○	○	○
Does the app cover the medical condition as well as including related topics?	○	○	○
Is the level of detail provided adequate for this population's educational needs?	○	○	○

Q44 When considering people seeking guidance for restaurant eating

	Yes	Maybe	No
Is the app appropriate?	○	○	○
Does the app cover the topic comprehensively?	○	○	○
Does the app cover the medical condition as well as including related topics?	○	○	○
Is the level of detail provided adequate for this population's educational needs?	○	○	○

Q45 When considering people seeking weight loss support

	Yes	Maybe	No
Is the app appropriate?	○	○	○
Does the app cover the topic comprehensively?	○	○	○
Does the app cover the medical condition as well as including related topics?	○	○	○
Is the level of detail provided adequate for this population's educational needs?	○	○	○

Q46 When considering people seeking nutrition education

	Yes	Maybe	No
Is the app appropriate?	○	○	○
Does the app cover the topic comprehensively?	○	○	○
Does the app cover the medical condition as well as including related topics?	○	○	○
Is the level of detail provided adequate for this population's educational needs?	○	○	○

Q47 When considering the "other" target audience that you listed

	Yes	Maybe	No
Is the app appropriate?	○	○	○
Does the app cover the topic comprehensively?	○	○	○
Does the app cover the medical condition as well as including related topics?	○	○	○
Is the level of detail provided adequate for this population's educational needs?	○	○	○

APPENDIX C: HYPERTENSION APP EVALUTATION SURVEY

CVD App Evaluation Pre-survey

Are you a registered dietitian?
- ❍ Yes
- ❍ No

Do you currently work with patients or clients to manage or prevent cardiovascular disease?
- ❍ Yes
- ❍ No

Have you worked with patients or clients to manage or prevent cardiovascular disease for at least 1 year?
- ❍ Yes
- ❍ No, my work does not include people preventing or managing heart disease
- ❍ No, I work with people to prevent or manage heart disease, but for less than 1 year

Please select one of the following regarding mobile apps:
- ❍ I have never used a mobile app
- ❍ I personally use apps, but do not incorporate apps into my job as a dietitian
- ❍ I do not personally use apps, but I incorporate apps into my job as a dietian
- ❍ I personally use apps, and I incorporate apps into my job as a dietitian

How many years old are you?

How many years have you been a registered dietitian?

What is your gender?
- ❍ Male
- ❍ Female
- ❍ Prefer not to answer

Please indicate your current practice setting(s) (check all that apply):
- ❑ Inpatient
- ❑ Outpatient or ambulatory care
- ❑ Community/outreach
- ❑ Food service
- ❑ Private practice
- ❑ Resesarch
- ❑ Education
- ❑ Group home
- ❑ Assisted living
- ❑ Employee health
- ❑ Health advocacy
- ❑ Health coaching
- ❑ Other _____

Please indicate any previous practice setting(s) (check all that apply:

- ❑ Inpatient
- ❑ Outpatient or ambulatory care
- ❑ Community/outreach
- ❑ Food service
- ❑ Private practice
- ❑ Resesarch
- ❑ Education
- ❑ Group home
- ❑ Assisted living
- ❑ Employee health
- ❑ Health advocacy
- ❑ Health coaching
- ❑ Other _____

Thank you for your interest in evaluating apps. We will be emailing you shortly with more information on completing the app evaluations. Please enter your preferred email below.

Thank you for your time and interest in evaluating apps. At this time you are not eligible for participation in the study.

CVD App Evaluation

Q1 The first questions are to clearly identify which app is being evaluated.

Q2 Please enter the ID number provided for you by email.

Q3 What is the name of the app you are evaluating?
- ❍ DASH Diet Guide by Cameron Sumrell
- ❍ DASH Diet Food Tracker by e-Havior Change, LLC
- ❍ HeartBP-Blood Pressure and Habit by HealthWe, LLC
- ❍ DASH Diet for Healthy Weight Loss, by Many People Inc.

Q4 What is the version number of the app (if the app has never been updated, please put Version 1)? You will find this when downloading the app.
- ❍ Version (example: 1.2) _____
- ❍ Not sure

Q5 Is this app the full app or a lite version of the app? You will find this when downloading the app, or on the app icon.
- ❍ Full
- ❍ Lite
- ❍ Unsure/Not applicable

Q6 The most recent revision date (or date of creation if no revisions) is:
- ❍ Within the last month
- ❍ Within the last 6 months
- ❍ Within the last year
- ❍ Longer than one year
- ❍ Date generated by application (does not apply to content)
- ❍ Not applicable

Q7 What "store" did you use to download the app?
- ❍ Google Play
- ❍ iTunes
- ❍ App Store
- ❍ Other (please provide name of store) _____

Q8 This next set of questions is to gather user information about the app. Please download the app if you have not already done so. Spend 10-15 minutes familiarizing yourself with and trying out all parts/features of the app. After using the app, please answer the rest of the questions. You may refer back to the app as you answer the questions.

Q9 Please select the device(s) you used to evaluate the app (please check all that apply)

- ❑ iPad
- ❑ iPhone
- ❑ Kindle
- ❑ Android
- ❑ Other, please list _____

Q10 Do you feel that the app has a clear purpose?

- ❍ Yes
- ❍ Maybe
- ❍ No

Q11 Does the app title accurately describe the content of the app?

- ❍ Title describes the content very accurately
- ❍ Title mostly describes the content accurately
- ❍ Title is somewhat related to the content
- ❍ Title is hardly related to the content
- ❍ Title does not relate to the content in any way

Q12 In your opinion does the app try to...

	Yes	No
increase knowledge?	❍	❍
develop a skill?	❍	❍
change behavior?	❍	❍

Q13 Do you think the app will...

	Definitely yes	Probably yes	Maybe	Probably not	Definitely not
increase the user's knowledge?	❍	❍	❍	❍	❍
lead to the development of a skill?	❍	❍	❍	❍	❍
lead to behavior change?	❍	❍	❍	❍	❍

Q14 When considering activities within the app, please answer the following:

	Very likely	Likely	Somewhat likely	Unlikely	Very unlikely
Will the activities help the user to increase knowledge?	❍	❍	❍	❍	❍
Will the activities help the user to change behavior?	❍	❍	❍	❍	❍
Will the activities help the user to develop a skill?	❍	❍	❍	❍	❍

Q15 Please answer the following questions:

	Definitely yes	Probably yes	Maybe	Probably not	Definitely not
Would your friends use this app?	❍	❍	❍	❍	❍
Do you intend to use this app in the future?	❍	❍	❍	❍	❍
Will you do something differently after using this app?	❍	❍	❍	❍	❍
Will you try to do something new after using this app?	❍	❍	❍	❍	❍

Q16 How well does the app provide:

	Very well	Well	Adequately	Poorly	Very poorly
Information?	❍	❍	❍	❍	❍
Feedback on progress?	❍	❍	❍	❍	❍
Timely feedback whenever needed?	❍	❍	❍	❍	❍

Q17 Is feedback provided when the user participates in an activity in the app?

❍ Yes
❍ No
❍ Not applicable

Q18 Please rate the following:

	Very good	Good	Ok	Bad	Very bad
Speed of loading the app	❍	❍	❍	❍	❍
The user's ability to "retrace their steps" if they need to	❍	❍	❍	❍	❍
Transitions from page to page	❍	❍	❍	❍	❍
Function of any animations (quick & functional - slow & fragmented)	❍	❍	❍	❍	❍
Design of menus and icons	❍	❍	❍	❍	❍
Ease of navigation to the app's various features	❍	❍	❍	❍	❍

Q19 This set of questions refers to what the app is for, and who it is for.

Q20 Is the app appropriate for adults in terms of

	Yes	Maybe	No
Maturity level	❍	❍	❍
Nutrition needs	❍	❍	❍
Cognitive abilities	❍	❍	❍
Color scheme	❍	❍	❍
Readability	❍	❍	❍

Q21 When considering people seeking help learning and using the DASH diet to prevent or manage hypertension?

	Yes	Maybe	No
Is the app appropriate?	❍	❍	❍
Does the app cover the topic comprehensively?	❍	❍	❍
Does the app cover the medical condition as well as including related topics?	❍	❍	❍
Is the level of detail provided adequate for this population's educational needs?	❍	❍	❍

Q22 The overall educational value of the app is:

❍ Excellent
❍ Very Good
❍ Good
❍ Fair
❍ Poor
❍ Does not apply

Q23 Do you feel that the content of the app reflects what most professionals in the field would support?

❍ Definitely yes
❍ Probably yes
❍ Maybe
❍ Probably not
❍ Definitely not
❍ Do not know

APPENDIX D: MEALS FOR A HEALTHY HEART PARTICIPANT SURVEYS

Participant ID#

Meals for a Healthy Heart-Baseline Survey

DEMOGRAPHICS

1. How many years old are you?

2. What is your gender?
- ❍ Male
- ❍ Female
- ❍ Other

3. What is the highest academic degree you have obtained?
- ❍ Less than high school
- ❍ High school diploma
- ❍ Associate degree
- ❍ Bachelors degree
- ❍ Masters degree
- ❍ Doctoral degree

4. Ethnicity Identification (select one)"
- ❍ Hispanic or Latino
- ❍ Not Hispanic or Latino

5. Race Identification (select one or more):
- ❍ American Indian or Alaska Native
- ❍ Asian
- ❍ Black or African American
- ❍ Native Hawaiian or Other Pacific Islander
- ❍ White

6. Has a doctor diagnosed you with high blood pressure?
- ❍ No, I have never been told I have high blood pressure
- ❍ Yes, I have been told I have prehypertension
- ❍ Yes, I have been told I have hypertension

7. Do you own a mobile device? (select all that apply)
- ❑ No
- ❑ iPhone
- ❑ Android phone
- ❑ iPad
- ❑ Tablet

Participant ID#

8. Do you use apps on mobile devices?
- ❍ Frequently
- ❍ Often
- ❍ Sometimes
- ❍ Never

9. Do you use health apps on mobile devices?
- ❍ Frequently
- ❍ Often
- ❍ Sometimes
- ❍ Never

10. Do you use diet/nutrition apps on mobile devices?
- ❍ Frequently
- ❍ Often
- ❍ Sometimes
- ❍ Never

11. How tall are you?

_____Feet _____Inches

12. How much do you weigh?

_____Pounds

Participant ID#

For the next questions, please answer thinking about diet apps on a mobile device (smartphone, tablet computer)

13. Performance Expectancy

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I would find diet apps useful in managing/preventing high blood pressure	❍	❍	❍	❍	❍	❍	❍
Using diet apps enables me to accomplish tasks more quickly	❍	❍	❍	❍	❍	❍	❍
Using diet apps increases my productivity	❍	❍	❍	❍	❍	❍	❍
If I use diet apps, I will increase my chances of improving my blood pressure	❍	❍	❍	❍	❍	❍	❍

14. Effort Expectancy

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
My interaction with diet apps would be clear and understandable	❍	❍	❍	❍	❍	❍	❍
It would be easy for me to become skillful at using diet apps	❍	❍	❍	❍	❍	❍	❍
I would find diet apps easy to use	❍	❍	❍	❍	❍	❍	❍
Learning to operate diet apps is easy for me	❍	❍	❍	❍	❍	❍	❍

Participant ID#

15. Attitude Toward Using Technology

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
Using diet apps is a good idea	❍	❍	❍	❍	❍	❍	❍
Diet apps make managing/preventing high blood pressure more interesting	❍	❍	❍	❍	❍	❍	❍
Working with diet apps is fun	❍	❍	❍	❍	❍	❍	❍
I like working with diet apps	❍	❍	❍	❍	❍	❍	❍

16. Social Influence

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
People who influence my behavior think that I should use diet apps	❍	❍	❍	❍	❍	❍	❍
People who are important to me think that I should use diet apps	❍	❍	❍	❍	❍	❍	❍
My health care team has been helpful in the use of diet apps	❍	❍	❍	❍	❍	❍	❍
In general, my health care team has supported my use of diet apps	❍	❍	❍	❍	❍	❍	❍

Participant ID#

17. Facilitating Conditions

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I have the resources necessary to use diet apps	❍	❍	❍	❍	❍	❍	❍
I have the knowledge necessary to use diet apps	❍	❍	❍	❍	❍	❍	❍
Diet apps are compatible with other technology that I use	❍	❍	❍	❍	❍	❍	❍
A specific person (or group) is available for assistance with diet app difficulties.	❍	❍	❍	❍	❍	❍	❍

18. Self-Efficacy: I could complete a job or task using diet apps...

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
If there was no one around to tell me what to do as I go	❍	❍	❍	❍	❍	❍	❍
If I could call someone for help if I got stuck	❍	❍	❍	❍	❍	❍	❍
If I had a lot of time to complete the job for which the app was provided	❍	❍	❍	❍	❍	❍	❍
If I had just the built-in help facility for assistance	❍	❍	❍	❍	❍	❍	❍

Participant ID#

19: Anxiety

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I feel apprehensive about using diet apps	❍	❍	❍	❍	❍	❍	❍
It scares me to think that I could lose a lot of information using diet apps by hitting the wrong key	❍	❍	❍	❍	❍	❍	❍
I hesitate to use diet apps for fear of making mistakes I cannot correct	❍	❍	❍	❍	❍	❍	❍
Diet apps are somewhat intimidating to me	❍	❍	❍	❍	❍	❍	❍

20. Behavioral Intention

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I intend to use diet apps in the next 3 months	❍	❍	❍	❍	❍	❍	❍
I predict I would use diet apps in the next 3 months	❍	❍	❍	❍	❍	❍	❍
I plan to use diet apps in the next 3 months	❍	❍	❍	❍	❍	❍	❍

Participant ID#

DASH-Q (DASH-Quality)

The following questions ask about your hypertension (high blood pressure) diet self-care activities during the past 7 days. For each question, select the number of days that you performed that activity.

21. How many of the past 7 days did you:

	0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days
Eat nuts or peanut butter	❍	❍	❍	❍	❍	❍	❍	❍
Eat beans, peas or lentils	❍	❍	❍	❍	❍	❍	❍	❍
Eat eggs	❍	❍	❍	❍	❍	❍	❍	❍
Eat pickles, olives or other vegetables in brine	❍	❍	❍	❍	❍	❍	❍	❍
Eat 5 or more servings of fruits and vegetables	❍	❍	❍	❍	❍	❍	❍	❍
Eat more than one serving of fruit	❍	❍	❍	❍	❍	❍	❍	❍
Eat more than one serving of vegetables	❍	❍	❍	❍	❍	❍	❍	❍
Drink milk (in a glass, with cereal or in coffee, tea or cocoa)	❍	❍	❍	❍	❍	❍	❍	❍
Eat broccoli, collard greens, spinach, potatoes, squash or sweet potatoes	❍	❍	❍	❍	❍	❍	❍	❍
Eat apples, bananas, oranges, melon or raisins	❍	❍	❍	❍	❍	❍	❍	❍
Eat whole-grain breads, cereals, grits, oatmeal or brown rice	❍	❍	❍	❍	❍	❍	❍	❍

HELM (Hypertension Evaluation of Lifestyle and Management Knowledge Scale)

22. A person is considered to have hypertension if either their systolic blood pressure is 140 or their diastolic is 90 or higher on two separate occasions.

❍ True
❍ False

23. Most people can tell when their blood pressure is high because they feel bad.

❍ True
❍ False

Participant ID#

24. Uncontrolled hypertension can lead to which of the following
- ❍ Lung cancer
- ❍ Kidney failure
- ❍ High choleserol
- ❍ Diabetes

25. Which of the following increases your risk of having hypertension?
- ❍ Weight lifting
- ❍ Drinking greater than 2 cups of coffee a day
- ❍ Smoking a pack of cigarettes
- ❍ Gaining 15 pounds

26. People with hypertension do not need to take medicine if they exercise regularly
- ❍ True
- ❍ False

27. Which of the following statements about taking blood pressure medicine is TRUE?
- ❍ Blood pressure medicine should always be taken with food
- ❍ More than one type of blood pressure medicine can be taken at the same time
- ❍ Blood pressure medicine works best if taken at bedtime
- ❍ Blood pressure medicine should not be taken if a person drank alcohol that day

28. Most of the salt Americans eat is added with a salt shaker
- ❍ True
- ❍ False

29. There are about as many calories in 12 ounces of regular orange juice as there are in 12 ounces of regular cola
- ❍ True
- ❍ False

30. An overweight 60-year-old man has hypertension. He drinks one bottle of beer and 4 cups of regular coffee a day. He adds regular table salt to his food at most meals. Which one of the following changes is most likely to lower his blood pressure?
- ❍ Lose 10 pounds
- ❍ Stop drinking alcohol
- ❍ Switch to decaffeinated coffee
- ❍ Switch to sea salt.

Participant ID#

31. Which one of the following changes to your diet is most likely to lower blood pressure?
- ❍ Eat more fruits, vegetables, whole grains and low-fat dairy products
- ❍ Eliminate spicy foods
- ❍ Drink one glass of red wine daily
- ❍ Drink herbal tea instead of coffee

32. Which one of the following statements about exercise and blood pressure is TRUE?
- ❍ People who are on their feet most of the day will not benefit from more exercise
- ❍ Exercising for 30 minutes every day lowers blood pressure more than exercising 30 minutes, 3 days a week
- ❍ Weight lifting should be avoided by people with high blood pressure
- ❍ When exercising, you must raise your heart rate to at least 100 beats a minute to improve blood pressure

33. A man reports that his blood pressure is 148/78 mm Hg when he checks it using the blood pressure in the pharmacy, 144/66 mm Hg in his family doctor's office, and 132/74 mm Hg when he checks it at home. Which of the following statements is TRUE?
- ❍ It is common for blood pressure readings to vary like this
- ❍ The highest blood pressure reading is the correct one
- ❍ The lowest blood pressure reading is the correct one
- ❍ He can be reassured that his blood pressure is normal

34. When measuring your blood pressure at home, you should:
- ❍ Always take your reading before you take your blood pressure medicine
- ❍ Take several readings, a minute or 2 apart, and record the lowest one
- ❍ Take your blood pressure right after exercising and at least 2 hours after a meal
- ❍ Take two readings, a minute or 2 apart, and write down the average value

35. Blood pressure is measured with two numbers, an upper number and a lower number. It is usually written as upper/lower. If someone is told that their goal blood pressure is 126/76, when have they reached that goal?
- ❍ When the upper is below 126 and the lower is below 76
- ❍ When the upper is below 126, even if the lower is over 76
- ❍ When the lower is below 76 even in if the upper is over 126
- ❍ When the average of the upper and the lower is

Participant ID#

HBP SCP (Hypertension Self-care Profile)

36. How often do you do the following?

	Never	Sometimes	Often	Always
Take part in regular physical activity (eg. 30 minutes of walking 4-5 times per week)?	❍	❍	❍	❍
Read nutrition facts labels to check information on sodium content?	❍	❍	❍	❍
Replace traditional high-salt foods (eg. Canned soups) with low-salt products (eg. Homemade soups, fresh vegetables)?	❍	❍	❍	❍
Limit use of high-salt condiments (eg, ketchup)?	❍	❍	❍	❍
Eat less than 1 teaspoon of table salt per day (6 grams)?	❍	❍	❍	❍
Eat less foods that are high in saturated (eg. Red meat, butter) and trans fat (eg. Shortening, lard)?	❍	❍	❍	❍
Use broiling, baking or steaming instead of frying when cooking?	❍	❍	❍	❍
Read nutrition label panel to check information on saturated (eg. Butter, red meat) and trans fat (eg. Lard, shortening)?	❍	❍	❍	❍
Replace traditional high-fat foods (eg. Deep fried chicken) with low-fat products (eg. Baked chicken)?	❍	❍	❍	❍
Limit total calorie intake from fat (less than 65 grams) daily?	❍	❍	❍	❍
Eat 5 or more servings of fruits and vegetables daily?	❍	❍	❍	❍
Practice moderation in drinking alcohol daily (2 glasses or less for men; 1 glass or less for women)?	❍	❍	❍	❍
Practice non-smoking?	❍	❍	❍	❍
Check your blood pressure at home?	❍	❍	❍	❍
Forget to take your blood pressure medicine?	❍	❍	❍	❍
Forget to fill your prescriptions	❍	❍	❍	❍
Keep your weight down?	❍	❍	❍	❍
Monitor situations that cause a high level of stress (eg. Arguments, death in the family) resulting in blood pressure elevation?	❍	❍	❍	❍
Engage in activities that can lower stress (eg. Deep breathing, meditation)?	❍	❍	❍	❍
See a doctor regularly?	❍	❍	❍	❍

Participant ID#

37. How important is it to you to do you do the following?

	Unimportant	Somewhat important	Important	Very important
Take part in regular physical activity (eg. 30 minutes of walking 4-5 times per week)?	❍	❍	❍	❍
Eat less processed foods (eg, canned or frozen goods, lunch meats)?	❍	❍	❍	❍
Read nutrition facts labels to check information on sodium content?	❍	❍	❍	❍
Replace traditional high-salt foods (eg. Canned soups) with low-salt products (eg. Homemade soups, fresh vegetables)?	❍	❍	❍	❍
Limit use of high-salt condiments (eg, ketchup)?	❍	❍	❍	❍
Eat less than 1 teaspoon of table salt per day (6 grams)?	❍	❍	❍	❍
Eat less foods that are high in saturated (eg. Red meat, butter) and trans fat (eg. Shortening, lard)?	❍	❍	❍	❍
Use broiling, baking or steaming instead of frying when cooking?	❍	❍	❍	❍
Read nutrition label panel to check information on saturated (eg. Butter, red meat) and trans fat (eg. Lard, shortening)?	❍	❍	❍	❍
Replace traditional high-fat foods (eg. Deep fried chicken) with low-fat products (eg. Baked chicken)?	❍	❍	❍	❍
Limit total calorie intake from fat (less than 65 grams) daily?	❍	❍	❍	❍
Eat 5 or more servings of fruits and vegetables daily?	❍	❍	❍	❍
Practice moderation in drinking alcohol daily (2 glasses or less for men; 1 glass or less for women)?	❍	❍	❍	❍
Practice non-smoking?	❍	❍	❍	❍
Check your blood pressure at home?	❍	❍	❍	❍
Take your blood pressure medicine?	❍	❍	❍	❍
Get your prescriptions filled?	❍	❍	❍	❍
Keep your weight down?	❍	❍	❍	❍
Try to stay away from anything and anybody that causes stress?	❍	❍	❍	❍
See a doctor regularly?	❍	❍	❍	❍

Participant ID#

38. How confident are you that you could do you do the following?

	Not confident	Somewhat confident	Confident	Very confident
Take part in regular physical activity (eg. 30 minutes of walking 4-5 times per week)?	❍	❍	❍	❍
Eat less processed foods (eg, canned or frozen goods, lunch meats)?	❍	❍	❍	❍
Read nutrition facts labels to check information on sodium content?	❍	❍	❍	❍
Replace traditional high-salt foods (eg. Canned soups) with low-salt products (eg. Homemade soups, fresh vegetables)?	❍	❍	❍	❍
Limit use of high-salt condiments (eg, ketchup)?	❍	❍	❍	❍
Eat less than 1 teaspoon of table salt per day (6 grams)?	❍	❍	❍	❍
Eat less foods that are high in saturated (eg. Red meat, butter) and trans fat (eg. Shortening, lard)?	❍	❍	❍	❍
Use broiling, baking or steaming instead of frying when cooking?	❍	❍	❍	❍
Read nutrition label panel to check information on saturated (eg. Butter, red meat) and trans fat (eg. Lard, shortening)?	❍	❍	❍	❍
Replace traditional high-fat foods (eg. Deep fried chicken) with low-fat products (eg. Baked chicken)?	❍	❍	❍	❍
Limit total calorie intake from fat (less than 65 grams) daily?	❍	❍	❍	❍
Eat 5 or more servings of fruits and vegetables daily?	❍	❍	❍	❍
Practice moderation in drinking alcohol daily (2 glasses or less for men; 1 glass or less for women)?	❍	❍	❍	❍
Practice non-smoking?	❍	❍	❍	❍
Check your blood pressure at home?	❍	❍	❍	❍
Take your blood pressure medicine?	❍	❍	❍	❍
Get your prescriptions filled?	❍	❍	❍	❍
Keep your weight down?	❍	❍	❍	❍
Try to stay away from anything and anybody that causes stress?	❍	❍	❍	❍
See a doctor regularly?	❍	❍	❍	❍

Meals for a Healthy Heart Follow Up Survey (Control Group)

Participant ID#
Month

1. Has a doctor diagnosed you with high blood pressure?
- ❍ No, I have never been told I have high blood pressure
- ❍ Yes, I have been told I have prehypertension
- ❍ Yes, I have been told I have hypertension

2. Do you own a mobile device? (select all that apply)
- ❑ No
- ❑ iPhone
- ❑ Android phone
- ❑ iPad
- ❑ Tablet

3. Do you use apps on mobile devices?
- ❍ Frequently
- ❍ Often
- ❍ Sometimes
- ❍ Never

4. Do you use health apps on mobile devices?
- ❍ Frequently
- ❍ Often
- ❍ Sometimes
- ❍ Never

5. Do you use diet/nutrition apps on mobile devices?
- ❍ Frequently
- ❍ Often
- ❍ Sometimes
- ❍ Never

6. How much do you weigh?

_____ Pounds

Meals for a Healthy Heart Follow Up Survey (Control Group) Participant ID# | Month

For the next questions, please answer thinking about diet apps on a mobile device (smartphone, tablet computer)

7. Performance Expectancy

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I would find diet apps useful in managing/preventing high blood pressure	❍	❍	❍	❍	❍	❍	❍
Using diet apps enables me to accomplish tasks more quickly	❍	❍	❍	❍	❍	❍	❍
Using diet apps increases my productivity	❍	❍	❍	❍	❍	❍	❍
If I use diet apps, I will increase my chances of improving my blood pressure	❍	❍	❍	❍	❍	❍	❍

8. Effort Expectancy

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
My interaction with diet apps would be clear and understandable	❍	❍	❍	❍	❍	❍	❍
It would be easy for me to become skillful at using diet apps	❍	❍	❍	❍	❍	❍	❍
I would find diet apps easy to use	❍	❍	❍	❍	❍	❍	❍
Learning to operate diet apps is easy for me	❍	❍	❍	❍	❍	❍	❍

Meals for a Healthy Heart Follow Up Survey (Control Group) Participant ID# | Month

9. Attitude Toward Using Technology

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
Using diet apps is a good idea	❍	❍	❍	❍	❍	❍	❍
Diet apps make managing/preventing high blood pressure more interesting	❍	❍	❍	❍	❍	❍	❍
Working with diet apps is fun	❍	❍	❍	❍	❍	❍	❍
I like working with diet apps	❍	❍	❍	❍	❍	❍	❍

10. Social Influence

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
People who influence my behavior think that I should use diet apps	❍	❍	❍	❍	❍	❍	❍
People who are important to me think that I should use diet apps	❍	❍	❍	❍	❍	❍	❍
My health care team has been helpful in the use of diet apps	❍	❍	❍	❍	❍	❍	❍
In general, my health care team has supported my use of diet apps	❍	❍	❍	❍	❍	❍	❍

Meals for a Healthy Heart Follow Up Survey (Control Group) Participant ID# Month

11. Facilitating Conditions

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I have the resources necessary to use diet apps	❍	❍	❍	❍	❍	❍	❍
I have the knowledge necessary to use diet apps	❍	❍	❍	❍	❍	❍	❍
Diet apps are compatible with other technology that I use	❍	❍	❍	❍	❍	❍	❍
A specific person (or group) is available for assistance with diet app difficulties.	❍	❍	❍	❍	❍	❍	❍

12. Self-Efficacy: I could complete a job or task using diet apps...

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
If there was no one around to tell me what to do as I go	❍	❍	❍	❍	❍	❍	❍
If I could call someone for help if I got stuck	❍	❍	❍	❍	❍	❍	❍
If I had a lot of time to complete the job for which the app was provided	❍	❍	❍	❍	❍	❍	❍
If I had just the built-in help facility for assistance	❍	❍	❍	❍	❍	❍	❍

Meals for a Healthy Heart Follow Up Survey (Control Group) Participant ID# | Month

13: Anxiety

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I feel apprehensive about using diet apps	❍	❍	❍	❍	❍	❍	❍
It scares me to think that I could lose a lot of information using diet apps by hitting the wrong key	❍	❍	❍	❍	❍	❍	❍
I hesitate to use diet apps for fear of making mistakes I cannot correct	❍	❍	❍	❍	❍	❍	❍
Diet apps are somewhat intimidating to me	❍	❍	❍	❍	❍	❍	❍

14. Behavioral Intention

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I intend to use diet apps in the next 3 months	❍	❍	❍	❍	❍	❍	❍
I predict I would use diet apps in the next 3 months	❍	❍	❍	❍	❍	❍	❍
I plan to use diet apps in the next 3 months	❍	❍	❍	❍	❍	❍	❍

Meals for a Healthy Heart Follow Up Survey (Control Group) Participant ID# Month

DASH-Q (DASH-Quality)

The following questions ask about your hypertension (high blood pressure) diet self-care activities during the past 7 days. For each question, select the number of days that you performed that activity.

15. How many of the past 7 days did you:

	0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days
Eat nuts or peanut butter	❍	❍	❍	❍	❍	❍	❍	❍
Eat beans, peas or lentils	❍	❍	❍	❍	❍	❍	❍	❍
Eat eggs	❍	❍	❍	❍	❍	❍	❍	❍
Eat pickles, olives or other vegetables in brine	❍	❍	❍	❍	❍	❍	❍	❍
Eat 5 or more servings of fruits and vegetables	❍	❍	❍	❍	❍	❍	❍	❍
Eat more than one serving of fruit	❍	❍	❍	❍	❍	❍	❍	❍
Eat more than one serving of vegetables	❍	❍	❍	❍	❍	❍	❍	❍
Drink milk (in a glass, with cereal or in coffee, tea or cocoa)	❍	❍	❍	❍	❍	❍	❍	❍
Eat broccoli, collard greens, spinach, potatoes, squash or sweet potatoes	❍	❍	❍	❍	❍	❍	❍	❍
Eat apples, bananas, oranges, melon or raisins	❍	❍	❍	❍	❍	❍	❍	❍
Eat whole-grain breads, cereals, grits, oatmeal or brown rice	❍	❍	❍	❍	❍	❍	❍	❍

HELM (Hypertension Evaluation of Lifestyle and Management Knowledge Scale)

16. A person is considered to have hypertension if either their systolic blood pressure is 140 or their diastolic is 90 or higher on two separate occasions.

❍ True
❍ False

17. Most people can tell when their blood pressure is high because they feel bad.

❍ True
❍ False

Meals for a Healthy Heart Follow Up Survey (Control Group) Participant ID# Month

18. Uncontrolled hypertension can lead to which of the following
- ❍ Lung cancer
- ❍ Kidney failure
- ❍ High cholesterol
- ❍ Diabetes

19. Which of the following increases your risk of having hypertension?
- ❍ Weight lifting
- ❍ Drinking greater than 2 cups of coffee a day
- ❍ Smoking a pack of cigarettes
- ❍ Gaining 15 pounds

20. People with hypertension do not need to take medicine if they exercise regularly
- ❍ True
- ❍ False

21. Which of the following statements about taking blood pressure medicine is TRUE?
- ❍ Blood pressure medicine should always be taken with food
- ❍ More than one type of blood pressure medicine can be taken at the same time
- ❍ Blood pressure medicine works best if taken at bedtime
- ❍ Blood pressure medicine should not be taken if a person drank alcohol that day

22. Most of the salt Americans eat is added with a salt shaker
- ❍ True
- ❍ False

23. There are about as many calories in 12 ounces of regular orange juice as there are in 12 ounces of regular cola
- ❍ True
- ❍ False

24. An overweight 60-year-old man has hypertension. He drinks one bottle of beer and 4 cups of regular coffee a day. He adds regular table salt to his food at most meals. Which one of the following changes is most likely to lower his blood pressure?
- ❍ Lose 10 pounds
- ❍ Stop drinking alcohol
- ❍ Switch to decaffeinated coffee
- ❍ Switch to sea salt.

Meals for a Healthy Heart Follow Up Survey (Control Group) Participant ID# Month

25. Which one of the following changes to your diet is most likely to lower blood pressure?
- ❍ Eat more fruits, vegetables, whole grains and low-fat dairy products
- ❍ Eliminate spicy foods
- ❍ Drink one glass of red wine daily
- ❍ Drink herbal tea instead of coffee

26. Which one of the following statements about exercise and blood pressure is TRUE?
- ❍ People who are on their feet most of the day will not benefit from more exercise
- ❍ Exercising for 30 minutes every day lowers blood pressure more than exercising 30 minutes, 3 days a week
- ❍ Weight lifting should be avoided by people with high blood pressure
- ❍ When exercising, you must raise your heart rate to at least 100 beats a minute to improve blood pressure

27. A man reports that his blood pressure is 148/78 mm Hg when he checks it using the blood pressure in the pharmacy, 144/66 mm Hg in his family doctor's office, and 132/74 mm Hg when he checks it at home. Which of the following statements is TRUE?
- ❍ It is common for blood pressure readings to vary like this
- ❍ The highest blood pressure reading is the correct one
- ❍ The lowest blood pressure reading is the correct one
- ❍ He can be reassured that his blood pressure is normal

28. When measuring your blood pressure at home, you should:
- ❍ Always take your reading before you take your blood pressure medicine
- ❍ Take several readings, a minute or 2 apart, and record the lowest one
- ❍ Take your blood pressure right after exercising and at least 2 hours after a meal
- ❍ Take two readings, a minute or 2 apart, and write down the average value

29. Blood pressure is measured with two numbers, an upper number and a lower number. It is usually written as upper/lower. If someone is told that their goal blood pressure is 126/76, when have they reached that goal?
- ❍ When the upper is below 126 and the lower is below 76
- ❍ When the upper is below 126, even if the lower is over 76
- ❍ When the lower is below 76 even in if the upper is over 126
- ❍ When the average of the upper and the lower is

Meals for a Healthy Heart Follow Up Survey (Control Group) Participant ID# | Month

HBP SCP (Hypertension Self-care Profile)

30. How often do you do the following?

	Never	Sometimes	Often	Always
Take part in regular physical activity (eg. 30 minutes of walking 4-5 times per week)?	❍	❍	❍	❍
Read nutrition facts labels to check information on sodium content?	❍	❍	❍	❍
Replace traditional high-salt foods (eg. Canned soups) with low-salt products (eg. Homemade soups, fresh vegetables)?	❍	❍	❍	❍
Limit use of high-salt condiments (eg, ketchup)?	❍	❍	❍	❍
Eat less than 1 teaspoon of table salt per day (6 grams)?	❍	❍	❍	❍
Eat less foods that are high in saturated (eg. Red meat, butter) and trans fat (eg. Shortening, lard)?	❍	❍	❍	❍
Use broiling, baking or steaming instead of frying when cooking?	❍	❍	❍	❍
Read nutrition label panel to check information on saturated (eg. Butter, red meat) and trans fat (eg. Lard, shortening)?	❍	❍	❍	❍
Replace traditional high-fat foods (eg. Deep fried chicken) with low-fat products (eg. Baked chicken)?	❍	❍	❍	❍
Limit total calorie intake from fat (less than 65 grams) daily?	❍	❍	❍	❍
Eat 5 or more servings of fruits and vegetables daily?	❍	❍	❍	❍
Practice moderation in drinking alcohol daily (2 glasses or less for men; 1 glass or less for women)?	❍	❍	❍	❍
Practice non-smoking?	❍	❍	❍	❍
Check your blood pressure at home?	❍	❍	❍	❍
Forget to take your blood pressure medicine?	❍	❍	❍	❍
Forget to fill your prescriptions	❍	❍	❍	❍
Keep your weight down?	❍	❍	❍	❍
Monitor situations that cause a high level of stress (eg. Arguments, death in the family) resulting in blood pressure elevation?	❍	❍	❍	❍
Engage in activities that can lower stress (eg. Deep breathing, meditation)?	❍	❍	❍	❍
See a doctor regularly?	❍	❍	❍	❍

Meals for a Healthy Heart Follow Up Survey (Control Group) Participant ID# | Month

31. How important is it to you to do you do the following?

	Unimportant	Somewhat important	Important	Very important
Take part in regular physical activity (eg. 30 minutes of walking 4-5 times per week)?	❍	❍	❍	❍
Eat less processed foods (eg, canned or frozen goods, lunch meats)?	❍	❍	❍	❍
Read nutrition facts labels to check information on sodium content?	❍	❍	❍	❍
Replace traditional high-salt foods (eg. Canned soups) with low-salt products (eg. Homemade soups, fresh vegetables)?	❍	❍	❍	❍
Limit use of high-salt condiments (eg, ketchup)?	❍	❍	❍	❍
Eat less than 1 teaspoon of table salt per day (6 grams)?	❍	❍	❍	❍
Eat less foods that are high in saturated (eg. Red meat, butter) and trans fat (eg. Shortening, lard)?	❍	❍	❍	❍
Use broiling, baking or steaming instead of frying when cooking?	❍	❍	❍	❍
Read nutrition label panel to check information on saturated (eg. Butter, red meat) and trans fat (eg. Lard, shortening)?	❍	❍	❍	❍
Replace traditional high-fat foods (eg. Deep fried chicken) with low-fat products (eg. Baked chicken)?	❍	❍	❍	❍
Limit total calorie intake from fat (less than 65 grams) daily?	❍	❍	❍	❍
Eat 5 or more servings of fruits and vegetables daily?	❍	❍	❍	❍
Practice moderation in drinking alcohol daily (2 glasses or less for men; 1 glass or less for women)?	❍	❍	❍	❍
Practice non-smoking?	❍	❍	❍	❍
Check your blood pressure at home?	❍	❍	❍	❍
Take your blood pressure medicine?	❍	❍	❍	❍
Get your prescriptions filled?	❍	❍	❍	❍
Keep your weight down?	❍	❍	❍	❍
Try to stay away from anything and anybody that causes stress?	❍	❍	❍	❍
See a doctor regularly?	❍	❍	❍	❍

Meals for a Healthy Heart Follow Up Survey (Control Group) Participant ID# Month

32. How confident are you that you could do you do the following?

	Not confident	Somewhat confident	Confident	Very confident
Take part in regular physical activity (eg. 30 minutes of walking 4-5 times per week)?	❍	❍	❍	❍
Eat less processed foods (eg, canned or frozen goods, lunch meats)?	❍	❍	❍	❍
Read nutrition facts labels to check information on sodium content?	❍	❍	❍	❍
Replace traditional high-salt foods (eg. Canned soups) with low-salt products (eg. Homemade soups, fresh vegetables)?	❍	❍	❍	❍
Limit use of high-salt condiments (eg, ketchup)?	❍	❍	❍	❍
Eat less than 1 teaspoon of table salt per day (6 grams)?	❍	❍	❍	❍
Eat less foods that are high in saturated (eg. Red meat, butter) and trans fat (eg. Shortening, lard)?	❍	❍	❍	❍
Use broiling, baking or steaming instead of frying when cooking?	❍	❍	❍	❍
Read nutrition label panel to check information on saturated (eg. Butter, red meat) and trans fat (eg. Lard, shortening)?	❍	❍	❍	❍
Replace traditional high-fat foods (eg. Deep fried chicken) with low-fat products (eg. Baked chicken)?	❍	❍	❍	❍
Limit total calorie intake from fat (less than 65 grams) daily?	❍	❍	❍	❍
Eat 5 or more servings of fruits and vegetables daily?	❍	❍	❍	❍
Practice moderation in drinking alcohol daily (2 glasses or less for men; 1 glass or less for women)?	❍	❍	❍	❍
Practice non-smoking?	❍	❍	❍	❍
Check your blood pressure at home?	❍	❍	❍	❍
Take your blood pressure medicine?	❍	❍	❍	❍
Get your prescriptions filled?	❍	❍	❍	❍
Keep your weight down?	❍	❍	❍	❍
Try to stay away from anything and anybody that causes stress?	❍	❍	❍	❍
See a doctor regularly?	❍	❍	❍	❍

Meals for a Healthy Heart Follow Up Survey (Control Group) Participant ID# | Month

Would you like to be entered into the drawing for a heart healthy cookbook?
- ❍ Yes
- ❍ No

Ethnicity Identification (select one)"
- ❍ Hispanic or Latino
- ❍ Not Hispanic or Latino

Race Identification (select one or more):
- ❍ American Indian or Alaska Native
- ❍ Asian
- ❍ Black or African American
- ❍ Native Hawaiian or Other Pacific Islander
- ❍ White

Before attending Meals for a Healthy Heart, have you ever received education on managing or preventing high blood pressure?
- ❍ Yes
- ❍ No

If yes, where did you receive the education? Please select all that apply.
- ❍ I have attended Meals for a Healthy Heart in the past (before February 2017)
- ❍ I have received high blood pressure education from my physician
- ❍ I have received high blood pressure education from a nurse
- ❍ I have received high blood pressure education from a registered dietitian
- ❍ I have read a book on high blood pressure
- ❍ I have read a pamphlet on high blood pressure
- ❍ I have looked up ways of managing or preventing high blood pressure online
- ❍ I have looked up apps to help manage/prevent high blood pressure
- ❍ Other (please list below)

Before attending Meals for a Healthy Heart, have you ever received education on the DASH diet?
- ❍ Yes
- ❍ No

Meals for a Healthy Heart Follow Up Survey (Control Group) Participant ID# Month

If yes, where did you receive the education? Please select all that apply.

- ❍ I have attended Meals for a Healthy Heart in the past (before February 2017)
- ❍ I have received DASH diet education from my physician
- ❍ I have received DASH diet education from a nurse
- ❍ I have received DASH diet education from a registered dietitian
- ❍ I have read a book on the DASH diet
- ❍ I have read a pamphlet on the DASH diet
- ❍ I have looked up the DASH diet online
- ❍ I have looked up DASH diet apps
- ❍ Other (please list below)

If an Extension Educator recommended an app for heart health, would you be willing to pay for the app if you were not reimbursed?

- ❍ Yes
- ❍ No, I do not own a iPad or iPhone
- ❍ No, I own an iPad or iPhone, but would not be willing to pay for an app

Meals for a Healthy Heart Follow Up Survey (App Group)

Participant ID# _____
Month _____

1. Has a doctor diagnosed you with high blood pressure?
- ❍ No, I have never been told that I have high blood pressure
- ❍ Yes, I have been told that I have prehypertension
- ❍ Yes, I have been told that I have hypertension

2. Do you own a mobile device? (select all that apply)
- ❑ No
- ❑ iPhone
- ❑ Android phone
- ❑ iPad
- ❑ Tablet

3. Do you use apps on mobile devices?
- ❍ Frequently
- ❍ Often
- ❍ Sometimes
- ❍ Never

4. Do you use health apps on mobile devices?
- ❍ Frequently
- ❍ Often
- ❍ Sometimes
- ❍ Never

5. Do you use diet/nutrition apps on mobile devices?
- ❍ Frequently
- ❍ Often
- ❍ Sometimes
- ❍ Never

6. How much do you weigh?

_____ Pounds

Meals for a Healthy Heart Follow Up Survey (App Group)

Participant ID#
Month

7. How often do you use the DASH Diet Food Tracker app?

- ❍ Never
- ❍ Once a month
- ❍ 2-4 times per month
- ❍ Once a week
- ❍ 2-3 days a week
- ❍ 4-5 days a week
- ❍ 6-7 days a week
- ❍ Multiple times each day

8. How many minutes do you spend each time that you use the DASH Diet Food Tracker?

_____ Minutes

Meals for a Healthy Heart Follow Up Survey (App Group)

Participant ID#
Month

For the next questions, please answer thinking about the DASH Diet Food Tracker

9. Performance Expectancy

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I would find DASH Diet Food Tracker useful in managing/preventing high blood pressure	❍	❍	❍	❍	❍	❍	❍
Using DASH Diet Food Tracker enables me to accomplish tasks more quickly	❍	❍	❍	❍	❍	❍	❍
Using DASH Diet Food Tracker increases my productivity	❍	❍	❍	❍	❍	❍	❍
If I use DASH Diet Food Tracker, I will increase my chances of improving my blood pressure	❍	❍	❍	❍	❍	❍	❍

10. Effort Expectancy

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
My interaction with DASH Diet Food Tracker would be clear and understandable	❍	❍	❍	❍	❍	❍	❍
It would be easy for me to become skillful at using DASH Diet Food Tracker	❍	❍	❍	❍	❍	❍	❍
I would find DASH Diet Food Tracker easy to use	❍	❍	❍	❍	❍	❍	❍
Learning to operate DASH Diet Food Tracker is easy for me	❍	❍	❍	❍	❍	❍	❍

Meals for a Healthy Heart Follow Up Survey (App Group)

Participant ID#
Month

11. Attitude Toward Using Technology

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
Using DASH Diet Food Tracker is a good idea	❍	❍	❍	❍	❍	❍	❍
DASH Diet Food Tracker makes managing/preventing high blood pressure more interesting	❍	❍	❍	❍	❍	❍	❍
Working with DASH Diet Food Tracker is fun	❍	❍	❍	❍	❍	❍	❍
I like working with DASH Diet Food Tracker	❍	❍	❍	❍	❍	❍	❍

12. Social Influence

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
People who influence my behavior think that I should use DASH Diet Food Tracker	❍	❍	❍	❍	❍	❍	❍
People who are important to me think that I should use DASH Diet Food Tracker	❍	❍	❍	❍	❍	❍	❍
My health care team has been helpful in the use of DASH Diet Food Tracker	❍	❍	❍	❍	❍	❍	❍
In general, my health care team has supported my use of DASH Diet Food Tracker	❍	❍	❍	❍	❍	❍	❍

Meals for a Healthy Heart Follow Up Survey (App Group)

Participant ID#
Month

13. Facilitating Conditions

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I have the resources necessary to use DASH Diet Food Tracker	❍	❍	❍	❍	❍	❍	❍
I have the knowledge necessary to use DASH Diet Food Tracker	❍	❍	❍	❍	❍	❍	❍
DASH Diet Food Tracker is compatible with other technology that I use	❍	❍	❍	❍	❍	❍	❍
A specific person (or group) is available for assistance with DASH Diet Food Tracker difficulties.	❍	❍	❍	❍	❍	❍	❍

14. Self-Efficacy: **I could complete a job or task using DASH Diet Food Tracker...**

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
If there was no one around to tell me what to do as I go	❍	❍	❍	❍	❍	❍	❍
If I could call someone for help if I got stuck	❍	❍	❍	❍	❍	❍	❍
If I had a lot of time to complete the job for which the DASH Diet Food Tracker app was provided	❍	❍	❍	❍	❍	❍	❍
If I had just the built-in help facility for assistance	❍	❍	❍	❍	❍	❍	❍

Meals for a Healthy Heart Follow Up Survey (App Group)

Participant ID#
Month

15. Anxiety

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I feel apprehensive about using DASH Diet Food Tracker	❍	❍	❍	❍	❍	❍	❍
It scares me to think that I could lose a lot of information using DASH Diet Food Tracker by hitting the wrong key	❍	❍	❍	❍	❍	❍	❍
I hesitate to use DASH Diet Food Tracker for fear of making mistakes I cannot correct	❍	❍	❍	❍	❍	❍	❍
DASH Diet Food Tracker is somewhat intimidating to me	❍	❍	❍	❍	❍	❍	❍

16. Behavioral Intention

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I intend to use DASH Diet Food Tracker in the next 3 months	❍	❍	❍	❍	❍	❍	❍
I predict I would use DASH Diet Food Tracker in the next 3 months	❍	❍	❍	❍	❍	❍	❍
I plan to use DASH Diet Food Tracker in the next 3 months	❍	❍	❍	❍	❍	❍	❍

Meals for a Healthy Heart Follow Up Survey (App Group)

Participant ID# _____
Month _____

DASH-Q (DASH-Quality)

The following questions ask about your hypertension (high blood pressure) diet self-care activities during the past 7 days. For each question, select the number of days that you performed that activity.

17. How many of the past 7 days did you:

	0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days
Eat nuts or peanut butter	❍	❍	❍	❍	❍	❍	❍	❍
Eat beans, peas or lentils	❍	❍	❍	❍	❍	❍	❍	❍
Eat eggs	❍	❍	❍	❍	❍	❍	❍	❍
Eat pickles, olives or other vegetables in brine	❍	❍	❍	❍	❍	❍	❍	❍
Eat 5 or more servings of fruits and vegetables	❍	❍	❍	❍	❍	❍	❍	❍
Eat more than one serving of fruit	❍	❍	❍	❍	❍	❍	❍	❍
Eat more than one serving of vegetables	❍	❍	❍	❍	❍	❍	❍	❍
Drink milk (in a glass, with cereal or in coffee, tea or cocoa)	❍	❍	❍	❍	❍	❍	❍	❍
Eat broccoli, collard greens, spinach, potatoes, squash or sweet potatoes	❍	❍	❍	❍	❍	❍	❍	❍
Eat apples, bananas, oranges, melon or raisins	❍	❍	❍	❍	❍	❍	❍	❍
Eat whole-grain breads, cereals, grits, oatmeal or brown rice	❍	❍	❍	❍	❍	❍	❍	❍

HELM (Hypertension Evaluation of Lifestyle and Management Knowledge Scale)

18. A person is considered to have hypertension if either their systolic blood pressure is 140 or their diastolic is 90 or higher on two separate occasions.

❍ True
❍ False

19. Most people can tell when their blood pressure is high because they feel bad.

❍ True
❍ False

Meals for a Healthy Heart Follow Up Survey (App Group) Participant ID# Month

20. Uncontrolled hypertension can lead to which of the following
- ❍ Lung cancer
- ❍ Kidney failure
- ❍ High choleserol
- ❍ Diabetes

21. Which of the following increases your risk of having hypertension?
- ❍ Weight lifting
- ❍ Drinking greater than 2 cups of coffee a day
- ❍ Smoking a pack of cigarettes
- ❍ Gaining 15 pounds

22. People with hypertension do not need to take medicine if they exercise regularly
- ❍ True
- ❍ False

23. Which of the following statements about taking blood pressure medicine is TRUE?
- ❍ Blood pressure medicine should always be taken with food
- ❍ More than one type of blood pressure medicine can be taken at the same time
- ❍ Blood pressure medicine works best if taken at bedtime
- ❍ Blood pressure medicine should not be taken if a person drank alcohol that day

24. Most of the salt Americans eat is added with a salt shaker
- ❍ True
- ❍ False

25. There are about as many calories in 12 ounces of regular orange juice as there are in 12 ounces of regular cola
- ❍ True
- ❍ False

26. An overweight 60-year-old man has hypertension. He drinks one bottle of beer and 4 cups of regular coffee a day. He adds regular table salt to his food at most meals. Which one of the following changes is most likely to lower his blood pressure?
- ❍ Lose 10 pounds
- ❍ Stop drinking alcohol
- ❍ Switch to decaffeinated coffee
- ❍ Switch to sea salt.

Meals for a Healthy Heart Follow Up Survey (App Group) Participant ID# Month

27. Which one of the following changes to your diet is most likely to lower blood pressure?
- ❍ Eat more fruits, vegetables, whole grains and low-fat dairy products
- ❍ Eliminate spicy foods
- ❍ Drink one glass of red wine daily
- ❍ Drink herbal tea instead of coffee

28. Which one of the following statements about exercise and blood pressure is TRUE?
- ❍ People who are on their feet most of the day will not benefit from more exercise
- ❍ Exercising for 30 minutes every day lowers blood pressure more than exercising 30 minutes, 3 days a week
- ❍ Weight lifting should be avoided by people with high blood pressure
- ❍ When exercising, you must raise your heart rate to at least 100 beats a minute to improve blood pressure

29. A man reports that his blood pressure is 148/78 mm Hg when he checks it using the blood pressure in the pharmacy, 144/66 mm Hg in his family doctor's office, and 132/74 mm Hg when he checks it at home. Which of the following statements is TRUE?
- ❍ It is common for blood pressure readings to vary like this
- ❍ The highest blood pressure reading is the correct one
- ❍ The lowest blood pressure reading is the correct one
- ❍ He can be reassured that his blood pressure is normal

30. When measuring your blood pressure at home, you should:
- ❍ Always take your reading before you take your blood pressure medicine
- ❍ Take several readings, a minute or 2 apart, and record the lowest one
- ❍ Take your blood pressure right after exercising and at least 2 hours after a meal
- ❍ Take two readings, a minute or 2 apart, and write down the average value

31. Blood pressure is measured with two numbers, an upper number and a lower number. It is usually written as upper/lower. If someone is told that their goal blood pressure is 126/76, when have they reached that goal?
- ❍ When the upper is below 126 and the lower is below 76
- ❍ When the upper is below 126, even if the lower is over 76
- ❍ When the lower is below 76 even in if the upper is over 126
- ❍ When the average of the upper and the lower is

Meals for a Healthy Heart Follow Up Survey (App Group)

Participant ID#
Month

HBP SCP (Hypertension Self-care Profile)

32. How often do you do the following?

	Never	Sometimes	Often	Always
Take part in regular physical activity (eg. 30 minutes of walking 4-5 times per week)?	❍	❍	❍	❍
Read nutrition facts labels to check information on sodium content?	❍	❍	❍	❍
Replace traditional high-salt foods (eg. Canned soups) with low-salt products (eg. Homemade soups, fresh vegetables)?	❍	❍	❍	❍
Limit use of high-salt condiments (eg, ketchup)?	❍	❍	❍	❍
Eat less than 1 teaspoon of table salt per day (6 grams)?	❍	❍	❍	❍
Eat less foods that are high in saturated (eg. Red meat, butter) and trans fat (eg. Shortening, lard)?	❍	❍	❍	❍
Use broiling, baking or steaming instead of frying when cooking?	❍	❍	❍	❍
Read nutrition label panel to check information on saturated (eg. Butter, red meat) and trans fat (eg. Lard, shortening)?	❍	❍	❍	❍
Replace traditional high-fat foods (eg. Deep fried chicken) with low-fat products (eg. Baked chicken)?	❍	❍	❍	❍
Limit total calorie intake from fat (less than 65 grams) daily?	❍	❍	❍	❍
Eat 5 or more servings of fruits and vegetables daily?	❍	❍	❍	❍
Practice moderation in drinking alcohol daily (2 glasses or less for men; 1 glass or less for women)?	❍	❍	❍	❍
Practice non-smoking?	❍	❍	❍	❍
Check your blood pressure at home?	❍	❍	❍	❍
Forget to take your blood pressure medicine?	❍	❍	❍	❍
Forget to fill your prescriptions	❍	❍	❍	❍
Keep your weight down?	❍	❍	❍	❍
Monitor situations that cause a high level of stress (eg. Arguments, death in the family) resulting in blood pressure elevation?	❍	❍	❍	❍
Engage in activities that can lower stress (eg. Deep breathing, meditation)?	❍	❍	❍	❍
See a doctor regularly?	❍	❍	❍	❍

Meals for a Healthy Heart Follow Up Survey (App Group)

Participant ID#
Month

33. How important is it to you to do you do the following?

	Unimportant	Somewhat important	Important	Very important
Take part in regular physical activity (eg. 30 minutes of walking 4-5 times per week)?	❍	❍	❍	❍
Eat less processed foods (eg, canned or frozen goods, lunch meats)?	❍	❍	❍	❍
Read nutrition facts labels to check information on sodium content?	❍	❍	❍	❍
Replace traditional high-salt foods (eg. Canned soups) with low-salt products (eg. Homemade soups, fresh vegetables)?	❍	❍	❍	❍
Limit use of high-salt condiments (eg, ketchup)?	❍	❍	❍	❍
Eat less than 1 teaspoon of table salt per day (6 grams)?	❍	❍	❍	❍
Eat less foods that are high in saturated (eg. Red meat, butter) and trans fat (eg. Shortening, lard)?	❍	❍	❍	❍
Use broiling, baking or steaming instead of frying when cooking?	❍	❍	❍	❍
Read nutrition label panel to check information on saturated (eg. Butter, red meat) and trans fat (eg. Lard, shortening)?	❍	❍	❍	❍
Replace traditional high-fat foods (eg. Deep fried chicken) with low-fat products (eg. Baked chicken)?	❍	❍	❍	❍
Limit total calorie intake from fat (less than 65 grams) daily?	❍	❍	❍	❍
Eat 5 or more servings of fruits and vegetables daily?	❍	❍	❍	❍
Practice moderation in drinking alcohol daily (2 glasses or less for men; 1 glass or less for women)?	❍	❍	❍	❍
Practice non-smoking?	❍	❍	❍	❍
Check your blood pressure at home?	❍	❍	❍	❍
Take your blood pressure medicine?	❍	❍	❍	❍
Get your prescriptions filled?	❍	❍	❍	❍
Keep your weight down?	❍	❍	❍	❍
Try to stay away from anything and anybody that causes stress?	❍	❍	❍	❍
See a doctor regularly?	❍	❍	❍	❍

Meals for a Healthy Heart Follow Up Survey (App Group) Participant ID# Month

34. How confident are you that you could do you do the following?

	Not confident	Somewhat confident	Confident	Very confident
Take part in regular physical activity (eg. 30 minutes of walking 4-5 times per week)?	❍	❍	❍	❍
Eat less processed foods (eg, canned or frozen goods, lunch meats)?	❍	❍	❍	❍
Read nutrition facts labels to check information on sodium content?	❍	❍	❍	❍
Replace traditional high-salt foods (eg. Canned soups) with low-salt products (eg. Homemade soups, fresh vegetables)?	❍	❍	❍	❍
Limit use of high-salt condiments (eg, ketchup)?	❍	❍	❍	❍
Eat less than 1 teaspoon of table salt per day (6 grams)?	❍	❍	❍	❍
Eat less foods that are high in saturated (eg. Red meat, butter) and trans fat (eg. Shortening, lard)?	❍	❍	❍	❍
Use broiling, baking or steaming instead of frying when cooking?	❍	❍	❍	❍
Read nutrition label panel to check information on saturated (eg. Butter, red meat) and trans fat (eg. Lard, shortening)?	❍	❍	❍	❍
Replace traditional high-fat foods (eg. Deep fried chicken) with low-fat products (eg. Baked chicken)?	❍	❍	❍	❍
Limit total calorie intake from fat (less than 65 grams) daily?	❍	❍	❍	❍
Eat 5 or more servings of fruits and vegetables daily?	❍	❍	❍	❍
Practice moderation in drinking alcohol daily (2 glasses or less for men; 1 glass or less for women)?	❍	❍	❍	❍
Practice non-smoking?	❍	❍	❍	❍
Check your blood pressure at home?	❍	❍	❍	❍
Take your blood pressure medicine?	❍	❍	❍	❍
Get your prescriptions filled?	❍	❍	❍	❍
Keep your weight down?	❍	❍	❍	❍
Try to stay away from anything and anybody that causes stress?	❍	❍	❍	❍
See a doctor regularly?	❍	❍	❍	❍

Meals for a Healthy Heart Follow Up Survey (App Group)

Participant ID# _____
Month _____

Would you like to be entered into the drawing for a heart healthy cookbook?
- ❍ Yes
- ❍ No

Ethnicity Identification (select one)
- ❍ Hispanic or Latino
- ❍ Not Hispanic or Latino

Race Identification (select one or more):
- ❍ American Indian or Alaska Native
- ❍ Asian
- ❍ Black or African American
- ❍ Native Hawaiian or Other Pacific Islander
- ❍ White

Before attending Meals for a Healthy Heart, have you ever received education on managing or preventing high blood pressure?
- ❍ Yes
- ❍ No

If yes, where did you receive the education? Please select all that apply.
- ❍ I have attended Meals for a Healthy Heart in the past (before February 2017)
- ❍ I have received high blood pressure education from my physician
- ❍ I have received high blood pressure education from a nurse
- ❍ I have received high blood pressure education from a registered dietitian
- ❍ I have read a book on high blood pressure
- ❍ I have read a pamphlet on high blood pressure
- ❍ I have looked up ways of managing or preventing high blood pressure online
- ❍ I have looked up apps to help manage/prevent high blood pressure
- ❍ Other (please list below)

Before attending Meals for a Healthy Heart, have you ever received education on the DASH diet?
- ❍ Yes
- ❍ No

Meals for a Healthy Heart Follow Up Survey (App Group)

Participant ID#

Month

If yes, where did you receive the education? Please select all that apply.

- ❍ I have attended Meals for a Healthy Heart in the past (before February 2017)
- ❍ I have received DASH diet education from my physician
- ❍ I have received DASH diet education from a nurse
- ❍ I have received DASH diet education from a registered dietitian
- ❍ I have read a book on the DASH diet
- ❍ I have read a pamphlet on the DASH diet
- ❍ I have looked up the DASH diet online
- ❍ I have looked up DASH diet apps
- ❍ Other (please list below)

If an Extension Educator recommended the DASH Diet Food Tracker App, would you be willing to pay for the app if you were not reimbursed?

- ❍ Yes
- ❍ No

APPENDIX E: MEALS FOR A HEALTHY HEART EDUCATOR SURVEY

M4HH Educator Survey

Q1 Participant ID

Q2 What is your gender?
- ❍ Male
- ❍ Female
- ❍ Other

Q3 What is the highest academic degree you have obtained?
- ❍ Bachelor's Degree
- ❍ Master's Degree
- ❍ Doctoral Degree

Q4 Are you a registered dietitian?
- ❍ No
- ❍ Yes

Q5 Ethnicity Identification (select one)
- ❍ Hispanic or Latino
- ❍ Not Hispanic or Latino

Q6 Race Identification (select one or more)
- ❑ American Indian or Alaska Native
- ❑ Asian
- ❑ Black or African American
- ❑ Native Hawaiian or Other Pacific Islander
- ❑ White

Q7 Do you own a mobile device? (please select all that apply)
- ❑ No
- ❑ iPhone
- ❑ Android phone
- ❑ iPad
- ❑ Tablet

Q8 Do you use apps on mobile devices?
- ❍ Frequently
- ❍ Often
- ❍ Sometimes
- ❍ Never

Q9 Do you use health apps on mobile devices?
- ❍ Frequently
- ❍ Often
- ❍ Sometimes
- ❍ Never

Q10 Do you use diet/nutrition apps on mobile devices?
- ❍ Frequently
- ❍ Often
- ❍ Sometimes
- ❍ Never

Q11 For the next three questions, please do not include app use recommendations that were made during the recent Meals for a Healthy Heart study in your answers.

Q12 When providing Extension nutrition education programs, do you recommend apps to program participants?
- ❍ Frequently
- ❍ Often
- ❍ Sometimes
- ❍ Never

Q13 When providing Extension nutrition education programs, do you recommend health apps to program participants?
- ❍ Frequently
- ❍ Often
- ❍ Sometimes
- ❍ Never

Q14 When providing Extension nutrition education programs, do you recommend nutrition apps to program participants?
- ❍ Frequently
- ❍ Often
- ❍ Sometimes
- ❍ Never

Q15 For the next questions, please answer thinking about the incorporation of the DASH Diet Tracker app in the Meals for a Healthy Heart Program (M4HH). If you did not offer an app as part of the study, please answer how you would respond about adding an app for tracking DASH diet intake into future Meals for a Healthy Heart (M4HH) classes.

Q16 Performance Expectancy

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I would find DASH Diet Food Tracker useful for supporting M4HH	❍	❍	❍	❍	❍	❍	❍
Using DASH Diet Food Tracker enables me to accomplish M4HH tasks more quickly	❍	❍	❍	❍	❍	❍	❍
Using DASH Diet Food Tracker increases my productivity in M4HH	❍	❍	❍	❍	❍	❍	❍
If I use DASH Diet Food Tracker, I will increase my chances of getting a raise.	❍	❍	❍	❍	❍	❍	❍

Q17 Effort Expectancy

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
My interaction with DASH Diet Food Tracker would be clear and understandable	❍	❍	❍	❍	❍	❍	❍
It would be easy for me to become skillful at using DASH Diet Food Tracker in M4HH	❍	❍	❍	❍	❍	❍	❍
I would find DASH Diet Food Tracker easy to use as part of M4HH	❍	❍	❍	❍	❍	❍	❍
Learning to operate DASH Diet Food Tracker is easy for me	❍	❍	❍	❍	❍	❍	❍

Q18 Attitude Toward Using Technology

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
Using DASH Diet Food Tracker is a good idea	❍	❍	❍	❍	❍	❍	❍
Using DASH Diet Food Tracker makes managing/preventing high blood pressure more interesting	❍	❍	❍	❍	❍	❍	❍
Working with DASH Diet Food Tracker is fun	❍	❍	❍	❍	❍	❍	❍
I like working with DASH Diet Food Tracker	❍	❍	❍	❍	❍	❍	❍

Q19 Social Influence

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
People who influence my behavior think that I should use DASH Diet Food Tracker	❍	❍	❍	❍	❍	❍	❍
People who are important to me think that I should use DASH Diet Food Tracker	❍	❍	❍	❍	❍	❍	❍
My senior management of this business has been helpful in the use of DASH Diet Food Tracker	❍	❍	❍	❍	❍	❍	❍
In general, the organization has supported my use of DASH Diet Food Tracker	❍	❍	❍	❍	❍	❍	❍

Q20 Facilitating Conditions

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I have the resources necessary to use DASH Diet Food Tracker	❍	❍	❍	❍	❍	❍	❍
I have the knowledge necessary to use DASH Diet Food Tracker	❍	❍	❍	❍	❍	❍	❍
DASH Diet Food Tracker is compatible with other technology that I use	❍	❍	❍	❍	❍	❍	❍
A specific person (or group) is available for assistance with DASH Diet Food Tracker difficulties.	❍	❍	❍	❍	❍	❍	❍

Q21 Self-Efficacy: I could complete a job or task using diet apps...

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
If there was no one around to tell me what to do as I go	❍	❍	❍	❍	❍	❍	❍
If I could call someone for help if I got stuck	❍	❍	❍	❍	❍	❍	❍
If I had a lot of time to complete the job for which the app was provided	❍	❍	❍	❍	❍	❍	❍
If I had just the built-in help facility for assistance	❍	❍	❍	❍	❍	❍	❍

Q22 Anxiety

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I feel apprehensive about using DASH Diet Food Tracker in M4HH	❍	❍	❍	❍	❍	❍	❍
It scares me to think that I could lose a lot of information using DASH Diet Food Tracker by hitting the wrong key	❍	❍	❍	❍	❍	❍	❍
I hesitate to use DASH Diet Food Tracker for fear of making mistakes I cannot correct	❍	❍	❍	❍	❍	❍	❍
DASH Diet Food Tracker is somewhat intimidating to me	❍	❍	❍	❍	❍	❍	❍

Q23 Behavioral Intention

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I intend to use DASH Diet Food Tracker in M4HH in the next 12 months	❍	❍	❍	❍	❍	❍	❍
I predict I would use DASH Diet Food Tracker in M4HH in the next 12 months	❍	❍	❍	❍	❍	❍	❍
I plan to use DASH Diet Food Tracker in M4HH in the next 12 months	❍	❍	❍	❍	❍	❍	❍

APPENDIX F: MEALS FOR A HEALTHY HEART INTERVIEW SCRIPT

Before Interview:

Thank you for agreeing to answer questions about Meals for a Healthy Heart and apps. As a reminder, participation is voluntary. Do you mind if I audio record this interview? (If no, inform participant that notes will be taken). Do you have any questions before we begin? (Answer questions). If it is ok with you, we'll get started (start audio recording if participant agrees).

Interview Questions:

Acceptability

In what ways do the app and the program work well together?
In what ways did the app not work with M4HH?
How much of a demand is there for M4HH in your counties?

Implementation

How often do you offer M4HH to your counties?
To what extent did you implement the program as developed?
What barriers did you encounter in delivering the program?
What barriers did you encounter in offering the app?
What recommendations would you give to educators implementing M4HH with the app?
What recommendations do you have for improving M4HH?
What recommendation do you have for offering apps in the M4HH program in the future?

Practicality

Do you feel that you had adequate support marketing the Meals for a Healthy Heart program?
In what ways did you feel supported/unsupported?
Do you feel that offering an app during M4HH is practical for the future? In what ways is it practical/impractical?
What resources/support would you need to offer an app as part of M4HH?

Have you participated in research in the past?
Have you participated in program evaluation in the past?
Have you completed a thesis? What was it about?

APPENDIX G: COGNITIVE INTERVIEW SCRIPT FOR SURVEY OF DIETITIAN USE OF APPS IN HYPERTENSION CARE

Instructions:

1. Today we are testing a new survey of dietitian practices with the help of people like you. This interview will be audio recorded. Is that ok?

2. I'll ask you questions, and you'll answer them, just like a regular survey.

3. However, our goal here is to get a better idea of how the questions are working. So I'd like you to think aloud as you answer the questions, tell me what you are thinking about as you answer the questions.

4. At times I'll stop and ask more questions about terms, phrases, and what you think a question is asking. I'll also take notes.

5. Please keep in mind that I really want to hear all of your opinions and reactions. Don't hesitate to speak up whenever something seems unclear, is hard to answer, or doesn't seem to apply to you.

6. Finally, we'll do this for an hour, unless I run out of things to ask before then.

7. Do you have any questions before we start?

Age:

Sex:

Average amount of time spent with patients with heart disease each week:

Number of years working with patients with heart disease:

Years of experience as a registered dietitian:

Practice setting (inpatient, outpatient, community, other):

Probes

Q3:

What does working with patients/clients with heart disease mean to you?

What does clinical, outpatient, or community setting mean to you?

Are additional settings needed?

Q4 &5:

What does electronic devices mean to you in this question?

What electronic devices do you think should be included in this question?

What electronic devices should be excluded from this question?

How did you arrive at your answer?

Is another interval needed to answer this question?

Q6:

In your own words, what is this question asking?

What does “prevention or management” mean to you?

What diseases or conditions should be included in this question?

What diseases or conditions should be excluded in this question?

How did you arrive at your answer?

Q7 & 8:

In your own words, what is this question asking?

What diets/diet goals should be included in this question?

Excluded?

Q9:

In your own words, what is this question asking?

What aspects of the diet should be included/excluded from this question?

Q10:

What tools should be included/excluded from this question?

Q11:

In your own words, what is this question asking?

How did you arrive at your answer?

Q12:

In your own words, what is this question asking?

How did you arrive at your answer?

Q13

What does the term “health apps” mean to you?

What does “counseling or education in the management of hypertension” mean to you?

How did you arrive at your answer?

Q14:

In your own words, what is this question asking?

How did you arrive at your answer?

What sub-questions should be included/excluded from this question?

Q15:

How did you arrive at your answer?

Q16:

In your own words, what is this question asking?

Q17:

How did you arrive at your answer?

Q18:

In your own words, what is this question asking?

What sources on influence should be included/excluded?

Q19:

What tracking tools should be included/excluded from this question?

How did you arrive at your answer?

Q20:

What does “features in an app” mean to you?

What features should be included/excluded from this question?

Q21:

What does “feedback tools” mean to you?

What feedback tools should be included/excluded from this question?

Q22:

What does “general features” mean to you?

What general features should be included/excluded from this question?

Q23:

What does satisfied with apps mean to you?

Q24:

What does comfortable mean to you?

Q25-Q26:

How did you arrive at your answer?

Q27:

How did you arrive at your answer?

Q28:

How did you arrive at your answer?

Q29:

What considerations should be included/excluded from this question?
Q33:

What credentials should be included/excluded from this question?

Q34:

What options should be included/excluded from this question?

Q35:

What options should be included/excluded from this question?

Q36:

How did you arrive at your answer?

Q37:

How did you arrive at your answer?

What options should be included/excluded from this question?

Q40:

How did you arrive at your answer?

Q41:

How did you arrive at your answer?

Are there any additional questions that you feel would help this survey to more adequately assess dietitian practices regarding apps and management of hypertension?

APPENDIX H: SURVEY OF DIETITIAN USE OF APPS IN HYPERTENSION CARE

Q1 **Survey of Dietitian App Use in Counseling Patients with Hypertension.**

You are being asked to participate in a research study. Researchers are required to provide a consent form such as this one to tell you about the research, to explain that taking part is voluntary, to describe the risks and benefits of participation, and to help you to make an informed decision. You should feel free to ask the researchers any questions you may have.

Principal Investigator Name and Title: Karen Chapman-Novakofski, RD, PhD
Department and Institution: Food Science and Human Nutrition, University of Illinois
Address and Contact Information: 343 Bevier Hall, 905 S Goodwin Ave, Urbana, IL 61801

Why am I being asked?

You are being asked to be a subject in a research study surveying the incorporation of apps into education of patients/clients with heart disease. You have been asked to participate in the research because you are a dietitian. Your participation in this research is voluntary. Your decision whether or not to participate will not affect your current or future dealings with the University of Illinois at Urbana-Champaign. **If you decide to participate, you are free to withdraw at any time without affecting that relationship.**

Approximately 5,000 subjects may be involved in this research at UIUC.

What is the purpose of this research?

The purpose of this research is to better understand current practice for the use of apps and management of hypertension to inform future studies on the incorporation of mobile apps into dietetics care.

What procedures are involved?
This research will be performed as an online survey, which you will be able to complete in approximately 10-20 minutes from your own computer or mobile device. What are the potential risks and discomforts? To the best of our knowledge, the survey has no more risk of harm than you would experience in everyday life.

Are there benefits to taking part in the research?
This study is not designed to benefit you directly. This study is designed to learn more about the use of mobile apps in nutrition care. The study results may be used to help guide the incorporation of apps into dietetics practice in the future.

Will my study-related information be kept confidential?
Yes, but not always. In general, we will not tell anyone any information about you. When this research is discussed or published, no one will know that you were in the study. However, laws and university rules might require us to disclose information about you. For example, if required by laws or University Policy, study information which identifies you may be seen or copied by the following people or groups:

- The university committee and office that reviews and approves research studies
- The Institutional Review Board (IRB) and Office for Protection of Research Subjects
- University and state auditors, and Departments of the university responsible for oversight of research
- Federal government regulatory agencies such as the Office of Human Research Protections in the Department of Health and Human Services;

When the results of the research are published or discussed in conferences, no information will be included that would reveal your identity.

What are the costs for participating in this research?

There are no costs to you for participating in this research.

Will I be reimbursed for any of my expenses or paid for my participation in this research?

At the end of the survey, you will have the option of entering your email address to be entered into a drawing for 1 of 20 $50 Amazon gift cards.

Can I withdraw or be removed from the study?

If you decide to participate, you are free to withdraw your consent and discontinue participation at any time.

Who should I contact if I have questions?

Contact the researchers Karen Chapman-Novakofski at (217) 244-2852 or kmc@illinois.edu or Kristen DiFilippo at kdfilip@illinois.edu:

- if you have any questions about this study or your part in it,
- if you have questions, concerns or complaints about the research.

What are my rights as a research subject?

If you feel you have not been treated according to the descriptions in this form, or if you have any questions about your rights as a research subject, including questions, concerns, complaints, or to offer input, you may call the Office for the Protection of Research Subjects (OPRS) at 217-333-2670 or e-mail OPRS at irb@illinois.edu

What if I am a UIUC student?

You may choose not to participate or to stop your participation in this research at any time. This will not affect your class standing or grades at UIUC. The investigator may also end your participation in the research. If this happens, your class standing or grades will not be affected. You will not be offered or receive any special consideration if you participate in this research.

What if I am a UIUC employee?

Your participation in this research is in no way a part of your university duties, and your refusal to participate will not in any way affect your employment with the university, or the benefits, privileges, or opportunities associated with your employment at UIUC. You will not be offered or receive any special consideration if you participate in this research.

Remember:

Your participation in this research is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University. If you decide to participate, you are free to withdraw at any time without affecting that relationship.

I have read the above information. I agree to participate in this research.

❍ I agree to participate in this survey
❍ I do not wish to participate in this survey.

Have you previously completed this survey?

❍ Yes
❍ No

Q2 Are you a registered dietitian nutritionist?
❍ Yes
❍ No

Q3 Have you worked for a least the equivalent of 1 year as a dietitian in the management or prevention of cardiovascular disease?
❍ Yes
❍ No

Q4 Please answer the following, thinking about a work/professional setting (personal use will be covered in a later question). What types of electronic devices do you use for work/professional use?

	Regularly-part of daily routine	More than once a week	Weekly	Monthly	Seldom	Never
Laptop or desktop computer	❍	❍	❍	❍	❍	❍
Tablet or iPad	❍	❍	❍	❍	❍	❍
Smartphone	❍	❍	❍	❍	❍	❍
Wearable (eg. Fitbit)	❍	❍	❍	❍	❍	❍
Smartwatch	❍	❍	❍	❍	❍	❍
Pedometer or Accelerometer	❍	❍	❍	❍	❍	❍
Heart Rate Monitor	❍	❍	❍	❍	❍	❍
Body weight scale	❍	❍	❍	❍	❍	❍
Glucometer	❍	❍	❍	❍	❍	❍
Telehealth monitor	❍	❍	❍	❍	❍	❍
Other (please specify)	❍	❍	❍	❍	❍	❍

Q5 Please answer the following, thinking about your own personal use: What types of electronic devices do you use for personal use?

	Regularly-part of daily routine	More than once a week	Weekly	Monthly	Seldom	Never
Laptop or desktop computer	❍	❍	❍	❍	❍	❍
Tablet or iPad	❍	❍	❍	❍	❍	❍
Smartphone	❍	❍	❍	❍	❍	❍
Wearable (eg. Fitbit)	❍	❍	❍	❍	❍	❍
Smartwatch	❍	❍	❍	❍	❍	❍
Pedometer or Accelerometer	❍	❍	❍	❍	❍	❍
Heart Rate Monitor	❍	❍	❍	❍	❍	❍
Body weight scale	❍	❍	❍	❍	❍	❍
Glucometer	❍	❍	❍	❍	❍	❍
Telehealth monitor	❍	❍	❍	❍	❍	❍
Other (please specify)	❍	❍	❍	❍	❍	❍

Q6 Do you currently work in the area of prevention or management of any of the following conditions?

	Never	Seldom	Sometimes	Often	Always
Prehypertension	❍	❍	❍	❍	❍
Hypertension	❍	❍	❍	❍	❍
Dyslipidemia	❍	❍	❍	❍	❍
Coronary heart disease	❍	❍	❍	❍	❍
Cerebrovascular disease	❍	❍	❍	❍	❍
Peripheral arterial disease	❍	❍	❍	❍	❍
Congenital heart disease	❍	❍	❍	❍	❍
Weight Management	❍	❍	❍	❍	❍
Prediabetes	❍	❍	❍	❍	❍
Type 2 Diabetes	❍	❍	❍	❍	❍
Type 1 Diabetes	❍	❍	❍	❍	❍
Cardiac rehab	❍	❍	❍	❍	❍
Heart failure	❍	❍	❍	❍	❍
Metabolic syndrome	❍	❍	❍	❍	❍
Renal disease	❍	❍	❍	❍	❍

Q7 Which approaches do you use to guide nutrition education for patients/clients with hypertension?

	Always	Most of the time	Sometimes	Never
Mediterranean Diet	❍	❍	❍	❍
Dietary Approaches to Stop Hypertension (DASH)	❍	❍	❍	❍
MyPlate	❍	❍	❍	❍
Dietary Guidelines for Americans	❍	❍	❍	❍
Therapeutic Lifestyle Changes (TLC)	❍	❍	❍	❍
Other (please list)	❍	❍	❍	❍

Q8 Which of the following topics do you address in goal setting for patients/clients with hypertension?

	Always	Most of the time	Sometimes	Never
Fruits	❍	❍	❍	❍
Vegetables	❍	❍	❍	❍
Grains (1/2 grains whole)	❍	❍	❍	❍
Beans, nuts & seeds	❍	❍	❍	❍
Fats & oils	❍	❍	❍	❍
Olive oil	❍	❍	❍	❍
25-35% of total calories from fat	❍	❍	❍	❍
<30% of total calories from fat	❍	❍	❍	❍
<7 to 8% of total calories from saturated fat	❍	❍	❍	❍
<10% of total calories from saturated fat	❍	❍	❍	❍
Fat free/low fat dairy	❍	❍	❍	❍
Fish 2 times per week	❍	❍	❍	❍
Lean meat, poultry, fish, & eggs	❍	❍	❍	❍
Eggs	❍	❍	❍	❍
Limit sweets & added sugars	❍	❍	❍	❍
Protein	❍	❍	❍	❍
Limit added sugar to <10% of total calories	❍	❍	❍	❍
Limit trans fat	❍	❍	❍	❍
Reduce sodium intake	❍	❍	❍	❍
Weight loss	❍	❍	❍	❍
Reduce sodium intake	❍	❍	❍	❍
Limit sodium to <2300 mg per day	❍	❍	❍	❍
Limit sodium to <1500 mg per day	❍	❍	❍	❍
Moderate alcohol (≤1 drink per day for women ≤2 for men)	❍	❍	❍	❍
Red meat only a few times a month	❍	❍	❍	❍
Physical activity	❍	❍	❍	❍
Calories	❍	❍	❍	❍
Red wine	❍	❍	❍	❍
Decreasing cholesterol to	❍	❍	❍	❍
Increase soluble fiber	❍	❍	❍	❍
Add 2 g per day of plant stanols/sterols	❍	❍	❍	❍
Other (please list)	❍	❍	❍	❍

Q9 When encouraging diet tracking, what tools do you recommend?

	Always	Most of the time	About half the time	Sometimes	Never
Pen and paper	❍	❍	❍	❍	❍
Computer-based word processing (Word, Excel, etc.)	❍	❍	❍	❍	❍
Online Program or Website	❍	❍	❍	❍	❍
Smartphone apps	❍	❍	❍	❍	❍
Other (please specify)	❍	❍	❍	❍	❍

Q10 Do you ask your patients/clients to self-monitor through diet tracking?

- ❍ Always
- ❍ Most of the time
- ❍ Sometimes
- ❍ Occasionally
- ❍ Never

Q11 Do you evaluate your patients' tracking logs?

- ❍ Always
- ❍ Most of the time
- ❍ Sometimes
- ❍ Occasionally
- ❍ Never

Q12 Do you share health app resources related to prevention or management of hypertension with your clients, patients, or lay/community audiences?

- ❍ Yes
- ❍ Sometimes
- ❍ No

Q13 What are the reasons that you recommend using health-related apps to your clients/patients with hypertension compared to other methods?

	Strongly agree	Somewhat agree	Somewhat disagree	Strongly disagree	Not applicable
Apps help my clients/patients track their caloric intake more accurately	❍	❍	❍	❍	❍
Apps help my clients/patients track their physical activity more accurately	❍	❍	❍	❍	❍
Apps help my clients/patients track macronutrients more accurately	❍	❍	❍	❍	❍
Apps help my clients/patients track micronutrients more accurately	❍	❍	❍	❍	❍
Apps help my clients/patients make better food choices	❍	❍	❍	❍	❍
Apps help my clients/patients track their weight	❍	❍	❍	❍	❍
Apps help my clients/patients lose more weight	❍	❍	❍	❍	❍
Apps help my clients/patients better manage their medications	❍	❍	❍	❍	❍
Apps provide my clients/patients immediate feedback	❍	❍	❍	❍	❍
Apps are more user-friendly for my clients/patients	❍	❍	❍	❍	❍
Apps are less time consuming for my clients/patients	❍	❍	❍	❍	❍
Apps are more portable for my clients/patients	❍	❍	❍	❍	❍
Apps help my clients/patients learn new nutrition knowledge	❍	❍	❍	❍	❍
Apps support behavior change in my clients/patients	❍	❍	❍	❍	❍
Apps help my clients/patients learn new skills	❍	❍	❍	❍	❍
Apps help my clients/patients track their goals more accurately	❍	❍	❍	❍	❍
Apps help my clients/patients track their goals more frequently	❍	❍	❍	❍	❍
Apps are cost effective for my clients/patients	❍	❍	❍	❍	❍
Other (please specify)	❍	❍	❍	❍	❍

Q14 How effective are health-related smartphone apps in assisting you in the assessment of health-related behaviors listed below?

	Very effective	Effective	Neither effective nor ineffective	Ineffective	Very ineffective	I don't use or recommend smartphone apps to track this aspect of health
Dietary Intake	❍	❍	❍	❍	❍	❍
Physical Activity	❍	❍	❍	❍	❍	❍
Blood Pressure	❍	❍	❍	❍	❍	❍
Medications	❍	❍	❍	❍	❍	❍
Health Goals	❍	❍	❍	❍	❍	❍
Weight	❍	❍	❍	❍	❍	❍
Blood Glucose	❍	❍	❍	❍	❍	❍
Other (please specify)	❍	❍	❍	❍	❍	❍

Q15 What apps do you encourage your clients/patients to use for weight management? If more than one, please list your most preferred app first. If you do not use apps in counseling for weight management, type none.

Q16 What apps do you encourage your clients/patients to use for the management of hypertension? If more than one, please list in order of preference. If you do not use apps in counseling for hypertension, type none. If the same answer as above, type same.

Q17 How likely are you to use the following sources to find out about the apps that you use with your patients?

	Highly likely	Likely	Somewhat likely	Unlikely	Highly unlikely
A friend	❍	❍	❍	❍	❍
A family member	❍	❍	❍	❍	❍
A coworker/colleague	❍	❍	❍	❍	❍
A client/patient	❍	❍	❍	❍	❍
An app store search (iTunes, Google Play, etc.)	❍	❍	❍	❍	❍
An Internet search	❍	❍	❍	❍	❍
A peer reviewed journal (such as Journal of the Academy of Nutrition and Dietetics)	❍	❍	❍	❍	❍
A professional publication (such as Food & Nutrition Magazine)	❍	❍	❍	❍	❍
A professional association website (such as the American Heart Association or American Association of Diabetes Educators)	❍	❍	❍	❍	❍
List serve	❍	❍	❍	❍	❍
Electronic Mailing Lists	❍	❍	❍	❍	❍
Advertisements	❍	❍	❍	❍	❍
Other (please specify)	❍	❍	❍	❍	❍

Q18 How important are the following tracking tools in an app for the management of hypertension?

	Highly important	Moderate importance	Low importance	Not important
Food/dietary tracking with nutrition analysis	❍	❍	❍	❍
Weight tracking	❍	❍	❍	❍
Other body measurements	❍	❍	❍	❍
Fluid/water tracking	❍	❍	❍	❍
Fitness/physical activity tracking	❍	❍	❍	❍
Self-monitoring of blood glucose tracking	❍	❍	❍	❍
Medication tracking	❍	❍	❍	❍
Self-monitoring of blood pressure readings	❍	❍	❍	❍
Other (please specify)	❍	❍	❍	❍

Q19 How important are the following features in an app for the management of hypertension?

	Highly important	Moderate importance	Low importance	Not important
BMI calculator	❍	❍	❍	❍
Progress charts/graphs	❍	❍	❍	❍
Bar code scanning on food product labels	❍	❍	❍	❍
Ability to take photos of foods/drinks eaten	❍	❍	❍	❍
Meal plans	❍	❍	❍	❍
Grocery lists	❍	❍	❍	❍
Recipes	❍	❍	❍	❍
Restaurant food information	❍	❍	❍	❍
Automatic data collection (data collected without user entering it)	❍	❍	❍	❍
Text reminders	❍	❍	❍	❍
Calorie recommendations	❍	❍	❍	❍
Chat with a coach/expert	❍	❍	❍	❍
Social media support	❍	❍	❍	❍
Alerts	❍	❍	❍	❍
Alarms	❍	❍	❍	❍
Push notifications	❍	❍	❍	❍
Customizable to the app user	❍	❍	❍	❍
Other (please specify)	❍	❍	❍	❍

Q20 How important are the following general features in an app for the management of hypertension?

	Highly important	Moderate importance	Low importance	Not important
Video/graphical demonstrations	❍	❍	❍	❍
Ability to interact with social media (Facebook, Twitter, Instagram, etc.	❍	❍	❍	❍
Technical support	❍	❍	❍	❍
Other (please specify)	❍	❍	❍	❍

Q21a How satisfied are you with the apps available for assisting with management of hypertension?

- ❍ Extremely satisfied
- ❍ Somewhat satisfied
- ❍ Neither satisfied nor dissatisfied
- ❍ Somewhat dissatisfied
- ❍ Extremely dissatisfied

Q21b Please explain your answer

Q22 How confident do you personally feel using apps?

- ❍ Very confident
- ❍ Somewhat confident
- ❍ Uncertain
- ❍ Very uncertain

Q23 What barriers or limitations have you found with using health apps for yourself?

Q24 What barriers or limitations have your clients experienced using health apps?

Q25 How many of your clients/patients do you recommend health apps to?

- ❍ All
- ❍ Most
- ❍ Some
- ❍ Few
- ❍ None
- ❍ Not applicable (I do not recommend apps)

Q26 What proportion of your patients/clients in the following age groups would be able to use health apps?

	<20%	20-39%	40-59%	60-79%	80-100%	I don't work with this age group
<10 years old	❍	❍	❍	❍	❍	❍
11-18 years old	❍	❍	❍	❍	❍	❍
19-29 years old	❍	❍	❍	❍	❍	❍
30-49 years old	❍	❍	❍	❍	❍	❍
50-64 years old	❍	❍	❍	❍	❍	❍
65-75 years old	❍	❍	❍	❍	❍	❍
75+ years old	❍	❍	❍	❍	❍	❍

Q27 Which of the following do you consider when recommending a health app to a patient/client?

	Very important	Important	Neither important nor unimportant	Unimportant	Very unimportant
If patients/clients already use apps	❍	❍	❍	❍	❍
If patients/clients already use health apps	❍	❍	❍	❍	❍
If patients/clients have access to a smartphone or tablet	❍	❍	❍	❍	❍
Literacy level of patients/clients	❍	❍	❍	❍	❍
Health literacy level of patients/clients	❍	❍	❍	❍	❍
Language preference	❍	❍	❍	❍	❍
Other (please specify)	❍	❍	❍	❍	❍

Q28 What is your gender?
- ❍ Male
- ❍ Female
- ❍ I prefer not to answer

Q29 Ethnicity Identification (select one)
- ❍ Hispanic or Latino
- ❍ Not Hispanic or Latino

Q30 Race Identification (select one or more):
- ❑ American Indian or Alaska Native
- ❑ Asian
- ❑ Black or African American
- ❑ Native Hawaiian or Other Pacific Islander
- ❑ White

Q31 What is your age group?
- ❍ 20-29
- ❍ 30-39
- ❍ 40-49
- ❍ 50-59
- ❍ 60-69
- ❍ 70-79
- ❍ 80+

Q32 Please select your credentials (please select all that apply):
- ❑ RD/RDN
- ❑ DTR
- ❑ RN
- ❑ LPN
- ❑ APN
- ❑ PA
- ❑ MD
- ❑ CDE
- ❑ BC-ADM
- ❑ PharmD
- ❑ Other (please specify) _____

Q33 What is the highest level of education you have completed?

- ❍ 4 year degree
- ❍ Masters Degree
- ❍ Doctoral Degree
- ❍ Professional Degree (JD, MD)
- ❍ Other (please specify) _____

Q34 Please select any advanced training that you have completed:

- ❑ Certificate of Training in Adult Weight Management
- ❑ Certificate of Training in Pediatric and Adolescent Weight Management
- ❑ Board Certified Specialist in Pediatric Nutrition
- ❑ Board Certified Specialist in Oncology Nutrition
- ❑ Board Certified Specialist in Gerontological Nutrition
- ❑ Board Certified Specialist in Sports Nutrition
- ❑ Board Certified Specialist in Renal Nutrition
- ❑ Other (please specify) _____
- ❑ I do not have any advance training

Q35 Where do you consider yourself to be in your career?

- ❍ Early career (
- ❍ Mid career (10-20 years)
- ❍ Late career (>20 years)
- ❍ Retired with connection to profession
- ❍ Retired with no connection to profession
- ❍ I am no longer practicing (not retired)

Q36 Please indicate your current practice setting(s)-check all that apply:

- ❑ Inpatient
- ❑ Outpatient or Ambulatory Care
- ❑ Community/outreach
- ❑ Food service
- ❑ Private practice
- ❑ Corporate wellness
- ❑ Home care
- ❑ Grocery stores
- ❑ Research
- ❑ Education
- ❑ Public health
- ❑ Other (please specify) _____

Q37 In which state do you currently reside?

- ❍ Alabama
- ❍ Alaska
- ❍ Arizona
- ❍ Arkansas
- ❍ California
- ❍ Colorado
- ❍ Connecticut
- ❍ Delaware
- ❍ District of Columbia
- ❍ Florida
- ❍ Georgia
- ❍ Hawaii
- ❍ Idaho
- ❍ Illinois
- ❍ Indiana
- ❍ Iowa
- ❍ Kansas
- ❍ Kentucky
- ❍ Louisiana
- ❍ Maine
- ❍ Maryland
- ❍ Massachusetts
- ❍ Michigan
- ❍ Minnesota
- ❍ Mississippi
- ❍ Missouri
- ❍ Montana
- ❍ Nebraska
- ❍ Nevada
- ❍ New Hampshire
- ❍ New Jersey
- ❍ New Mexico
- ❍ New York
- ❍ North Carolina
- ❍ North Dakota
- ❍ Ohio
- ❍ Oklahoma
- ❍ Oregon
- ❍ Pennsylvania
- ❍ Puerto Rico
- ❍ Rhode Island
- ❍ South Carolina
- ❍ South Dakota
- ❍ Tennessee
- ❍ Texas
- ❍ Utah
- ❍ Vermont
- ❍ Virginia

- ❍ Washington
- ❍ West Virginia
- ❍ Wisconsin
- ❍ Wyoming
- ❍ I do not reside in the United States

Q38 In which state(s) are you licensed to practice? (please select all that apply)

- ❑ Alabama
- ❑ Alaska
- ❑ Arizona
- ❑ Arkansas
- ❑ California
- ❑ Colorado
- ❑ Connecticut
- ❑ Delaware
- ❑ District of Columbia
- ❑ Florida
- ❑ Georgia
- ❑ Hawaii
- ❑ Idaho
- ❑ Illinois
- ❑ Indiana
- ❑ Iowa
- ❑ Kansas
- ❑ Kentucky
- ❑ Louisiana
- ❑ Maine
- ❑ Maryland
- ❑ Massachusetts
- ❑ Michigan
- ❑ Minnesota
- ❑ Mississippi
- ❑ Missouri
- ❑ Montana
- ❑ Nebraska
- ❑ Nevada
- ❑ New Hampshire
- ❑ New Jersey
- ❑ New Mexico
- ❑ New York
- ❑ North Carolina
- ❑ North Dakota
- ❑ Ohio
- ❑ Oklahoma
- ❑ Oregon
- ❑ Pennsylvania
- ❑ Puerto Rico
- ❑ Rhode Island

- ❑ South Carolina
- ❑ South Dakota
- ❑ Tennessee
- ❑ Texas
- ❑ Utah
- ❑ Vermont
- ❑ Virginia
- ❑ Washington
- ❑ West Virginia
- ❑ Wisconsin
- ❑ Wyoming
- ❑ I do not reside in the United States

Q39 How many hours per week do you provide patient care or community education?

- ❍ Zero
- ❍ 1-10
- ❍ 11-20
- ❍ 21-30
- ❍ 30-40+

Q40 Please include any additional comments about your experience using health-related apps.

Q41 Thank you for completing our survey. Please enter your email address if you would like to be entered into a drawing for a $50 Amazon Gift Card.

APPENDIX I: IRB APPROVAL LETTERS

UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN

Office of the Vice Chancellor for Research

Office for the Protection of Research Subjects
528 East Green Street
Suite 203
Champaign, IL 61820

12/04/2014

Karen Chapman-Novakofski
Food Science & Human Nutrition
343 Bevier Hall
905 S Goodwin Ave
M/C 182

RE: *Evaluation of the Content Usability and Technology of Nutrition Educational Apps-Expert Panel Review of Survey Questions*
IRB Protocol Number: 15412

EXPIRATION DATE: December 03, 2017

Dear Dr. Chapman-Novakofski:

Thank you for submitting the completed IRB application form for your project entitled *Evaluation of the Content Usability and Technology of Nutrition Educational Apps-Expert Panel Review of Survey Questions*. Your project was assigned Institutional Review Board (IRB) Protocol Number 15412 and reviewed. It has been determined that the research activities described in this application meet the criteria for exemption at 45CFR46.101(b)(2).

This determination of exemption only applies to the research study as submitted. Please note that additional modifications to your project need to be submitted to the IRB for review and exemption determination or approval before the modifications are initiated.

We appreciate your conscientious adherence to the requirements of human subjects research. If you have any questions about the IRB process, or if you need assistance at any time, please feel free to contact me at the OPRS office, or visit our website at http://www.irb.illinois.edu.

Sincerely,

Rose St Clair

Rose St. Clair, BA
Assistant Human Subjects Research Specialist, Office for the Protection of Research Subjects

c: Kristen DiFilippo

telephone (217) 333-2670 • *fax* (217) 333-0405 • *email* IRB@illinois.edu

UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN

Office of the Vice Chancellor for Research

Office for the Protection of Research Subjects
528 East Green Street
Suite 203
Champaign, IL 61820

08/10/2015

Karen Chapman-Novakofski
Food Science & Human Nutrition
343 Bevier Hall
905 S Goodwin Ave
M/C 182

RE: *Evaluation of the Quality of Nutrition Education Apps*
IRB Protocol Number: 16093

EXPIRATION DATE: 08/09/2018

Dear Dr. Chapman-Novakofski:

Thank you for submitting the completed IRB application form for your project entitled *Evaluation of the Quality of Nutrition Education Apps*. Your project was assigned Institutional Review Board (IRB) Protocol Number 16093 and reviewed. It has been determined that the research activities described in this application meet the criteria for exemption at 45CFR46.101(b)(2).

This determination of exemption only applies to the research study as submitted. Please note that additional modifications to your project need to be submitted to the IRB for review and exemption determination or approval before the modifications are initiated.

We appreciate your conscientious adherence to the requirements of human subjects research. If you have any questions about the IRB process, or if you need assistance at any time, please feel free to contact me at the OPRS office, or visit our website at http://oprs.research.illinois.edu.

Sincerely,

Rose St Clair

Rose St. Clair, BA
Assistant Human Subjects Research Specialist, Office for the Protection of Research Subjects

c: Kristen DiFilippo

UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN

Office of the Vice Chancellor for Research

Office for the Protection of Research Subjects
528 East Green Street
Suite 203
Champaign, IL 61820

March 4, 2016

Karen Chapman-Novakofski
Food Science & Human Nutrition
343 Bevier Hall
905 S Goodwin Ave

RE: *Evaluation of MyFitness Pal using a Novel App Quality Assessment Tool (AQEL)*
IRB Protocol Number: 16660

Dear Dr. Chapman-Novakofski:

Thank you for submitting the completed IRB application form for your project entitled *Evaluation of MyFitness Pal using a Novel App Quality Assessment Tool (AQEL)*. Your project was assigned Institutional Review Board (IRB) Protocol Number 16660 and reviewed. It has been determined that the research activities described in this application meet the criteria for exemption at 45CFR46.101(b)(2).

This determination of exemption only applies to the research study as submitted. Please note that additional modifications to your project need to be submitted to the IRB for review and exemption determination or approval before the modifications are initiated.

Copies of the attached, date-stamped consent form(s) are to be used when obtaining informed consent. If there is a need to revise or alter the consent form(s), please submit the revised form(s) for IRB review, approval, and date-stamping prior to use.

Exempt protocols will be closed and archived five years from the date of approval. Researchers will be required to contact our office if the study will continue beyond five years. If an amendment is submitted once the study has been archived, researchers will need to submit a new application and obtain approval prior to implementing the change.

We appreciate your conscientious adherence to the requirements of human subjects research. If you have any questions about the IRB process, or if you need assistance at any time, please feel free to contact me at OPRS, or visit our website at http://oprs.research.illinois.edu

Sincerely,

Dustin L. Yocum

Dustin L. Yocum, MA, CIP
Human Subjects Research Specialist, Office for the Protection of Research Subjects

Exempt Approval - IRB #17396

Institutional Review Board
Sent: Wednesday, December 14, 2016 2:10 PM
To: Chapman-Novakofski, Karen Marie
Cc: DiFilippo, Kristen Nicole

IRB EXEMPT APPROVAL

RPI Name: Karen Chapman-Novakofski
Project Title: Evaluation of mobile apps for management and prevention of cardiovascular disease
IRB #: 17396
Approval Date: December 14, 2016

Thank you for submitting the completed IRB application form and related materials. Your application was reviewed by the UIUC Office for the Protection of Research Subjects (OPRS). OPRS has determined that the research activities described in this application meet the criteria for exemption at 45CFR46.101(b)(2). This message serves to supply OPRS approval for your IRB application.

Please contact OPRS if you plan to modify your project (change procedures, populations, consent letters, etc.). Otherwise you may conduct the human subjects research as approved for a period of five years. Exempt protocols will be closed and archived at the time of expiration. Researchers will be required to contact our office if the study will continue beyond five years.

Copies of the attached, date-stamped consent form(s) are to be used when obtaining informed consent.

We appreciate your conscientious adherence to the requirements of human subjects research. If you have any questions about the IRB process, or if you need assistance at any time, please feel free to contact me at OPRS, or visit our website at http://oprs.research.illinois.edu

Sincerely,

Michelle Lore

Michelle Lore
Human Subjects Research Specialist, Office for the Protection of Research Subjects

Attachment(s): Waiver of Documentation of Informed Consent, Informed Consent Document

c: Kristen DiFilippo

UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN

Office of the Vice Chancellor for Research

Office for the Protection of Research Subjects
528 East Green Street
Suite 203
Champaign, IL 61820

January 26, 2017

Karen Chapman-Novakofski
Food Science & Human Nutrition
343 Bevier Hall
905 S Goodwin Ave
Urbana, IL 61801

RE: *Meals for a Healthy Heart: Feasibility of incorporating a mobile app into a University Extension program targeting hypertension*
IRB Protocol Number: 17448

Dear Dr. Chapman-Novakofski:

This letter authorizes the use of human subjects in your project entitled *Meals for a Healthy Heart: Feasibility of incorporating a mobile app into a University Extension program targeting hypertension.* The University of Illinois at Urbana-Champaign Institutional Review Board (IRB) approved, by expedited review, the protocol as described in your IRB application. The expiration date for this protocol, IRB number 17448, is 01/24/2020. The risk designation applied to your project is *no more than minimal risk.*

Copies of the attached date-stamped consent form(s) must be used in obtaining informed consent. If there is a need to revise or alter the consent form(s), please submit the revised form(s) for IRB review, approval, and date-stamping prior to use.

Under applicable regulations, no changes to procedures involving human subjects may be made without prior IRB review and approval. The regulations also require that you promptly notify the IRB of any problems involving human subjects, including unanticipated side effects, adverse reactions, and any injuries or complications that arise during the project.

You were granted a three-year approval. If there are any changes to the protocol that result in your study becoming ineligible for the extended approval period, the RPI is responsible for immediately notifying the IRB via an amendment. The protocol will be issued a modified expiration date accordingly.

If you have any questions about the IRB process, or if you need assistance at any time, please feel free to contact me at the OPRS office, or visit our website at https://www.oprs.research.illinois.edu.

Sincerely,

Ron Banks, MS, CIP
Human Subjects Research Coordinator, Office for the Protection of Research Subjects

Attachment(s): 1 Consent Form

c: Kristen DiFilippo

UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN

Office of the Vice Chancellor for Research

Office for the Protection of Research Subjects
528 East Green Street
Suite 203
Champaign, IL 61820

March 7, 2017

Karen Chapman-Novakofski
Food Science & Human Nutrition
343 Bevier Hall
905 S Goodwin Ave
Urbana, IL 61801

RE: *Meals for a Healthy Heart: Feasibility of incorporating a mobile app into a University Extension program targeting hypertension*
IRB Protocol Number: 17448

Dear Dr. Chapman-Novakofski:

Thank you very much for forwarding the modifications to the University of Illinois at Urbana-Champaign Institutional Review Board (IRB) office for your project entitled *Meals for a Healthy Heart: Feasibility of incorporating a mobile app into a University Extension program targeting hypertension.* I will officially note for the record that these minor modifications to the original project, as noted in your correspondence received 2/6/2017, Making minor changes to follow-up surveys, have been approved. The expiration date for this protocol, IRB number 17448 is 01/24/2020. The risk designation applied to your project is *no more than minimal risk.*

Please note that additional modifications to your project need to be submitted to the IRB for review and approval before the modifications are initiated. To submit modifications to your protocol, please complete the IRB Research Amendment Form (see https://www.oprs.research.illinois.edu/forms-templates/forms/protocol-amendment-form). Unless modifications are made to this project, no further submittals are required to the IRB.

You were granted a three-year approval. If there are any changes to the protocol that result in your study becoming ineligible for the extended approval period, the RPI is responsible for immediately notifying the IRB via an amendment. The protocol will be issued a modified expiration date accordingly.

We appreciate your conscientious adherence to the requirements of human subjects research. If you have any questions about the IRB process, or if you need assistance at any time, please feel free to contact me at the OPRS office, or visit our website at https://www.oprs.research.illinois.edu.

Sincerely,

Ron Banks, MS, CIP
Human Subjects Research Coordinator, Office for the Protection of Research Subjects

c: Kristen DiFilippo

Exempt Approval - IRB #17687

Institutional Review Board

Sent: Thursday, April 13, 2017 11:32 AM
To: Chapman-Novakofski, Karen Marie
Cc: DiFilippo, Kristen Nicole
Attachments: IRBOCR_2017041328121.pdf (108 KB) ; IRBOCR_2017041328122.pdf (47 KB) ; IRBOCR_2017041328123.pdf (66 KB)

IRB EXEMPT APPROVAL

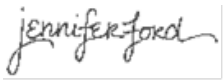
RPI Name: Dr. Karen Chapman-Novakofski
Project Title: ***Meals for a Healthy Heart: Assessing Feasibility of a Community Based Heart Disease Nutrition Program from the Educators' Perspectives***
IRB #: 17687
Approval Date: April 13, 2017

Thank you for submitting the completed IRB application form and related materials. Your application was reviewed by the UIUC Office for the Protection of Research Subjects (OPRS). OPRS has determined that the research activities described in this application meet the criteria for exemption at 45CFR46.101(b)(1). This message serves to supply OPRS approval for your IRB application.

Please contact OPRS if you plan to modify your project (change procedures, populations, consent letters, etc.). Otherwise you may conduct the human subjects research as approved for a period of five years. Exempt protocols will be closed and archived at the time of expiration. Researchers will be required to contact our office if the study will continue beyond five years.

We appreciate your conscientious adherence to the requirements of human subjects research. If you have any questions about the IRB process, or if you need assistance at any time, please feel free to contact me at OPRS, or visit our website at http://oprs.research.illinois.edu

Sincerely,



Jennifer Ford
Human Subjects Research Specialist, Office for the Protection of Research Subjects

Attachment(s): Approved research team attachment form, approved informed consent document, approved waiver of documentation of informed consent form

C: Kristen DiFilippo

Office of the Vice Chancellor for Research | Office for the Protection of Research Subjects
University of Illinois | Urbana-Champaign
805 West Pennsylvania Avenue, MC-095 | Urbana, IL 61801
Phone: (217) 333-2670 | Email: irb@illinois.edu
Website: http://oprs.research.illinois.edu

Office for the Protection of Research Subjects
Providing administrative support, services, and resources to the research community and the IRB

Exempt Approval - IRB #17259

Institutional Review Board

Sent: Tuesday, October 25, 2016 10:01 AM
To: Chapman-Novakofski, Karen Marie
Cc: DiFilippo, Kristen Nicole
Attachments: 17259_Attachments_10252016.pdf (122 KB)

IRB EXEMPT APPROVAL

RPI Name: Karen Chapman-Novakofski
Project Title: Face validation for a dietitian survey of app integration into counseling patients with hypertension.
IRB #: 17259
Approval Date: October 25, 2016

Thank you for submitting the completed IRB application form and related materials. Your application was reviewed by the UIUC Office for the Protection of Research Subjects (OPRS). OPRS has determined that the research activities described in this application meet the criteria for exemption at 45CFR46.101(b)(2). This message serves to supply OPRS approval for your IRB application.

Please contact OPRS if you plan to modify your project (change procedures, populations, consent letters, etc.). Otherwise you may conduct the human subjects research as approved for a period of five years. Exempt protocols will be closed and archived at the time of expiration. Researchers will be required to contact our office if the study will continue beyond five years.

Copies of the attached, date-stamped consent form(s) are to be used when obtaining informed consent.

We appreciate your conscientious adherence to the requirements of human subjects research. If you have any questions about the IRB process, or if you need assistance at any time, please feel free to contact me at OPRS, or visit our website at http://oprs.research.illinois.edu

Sincerely,

Michelle Lore

Michelle Lore
Human Subjects Research Specialist, Office for the Protection of Research Subjects

Attachment(s): Information Sheet, Waiver of Documentation of Informed Consent

c: Kristen DiFilippo

Exempt Approval - IRB #18028

Institutional Review Board

Sent: Wednesday, July 19, 2017 3:15 PM
To: Chapman-Novakofski, Karen Marie
Cc: DiFilippo, Kristen Nicole
Attachments: 18028_Attachments_07192017.pdf (199 KB)

IRB EXEMPT APPROVAL

RPI Name: Karen Chapman-Novakofski
Project Title: Dietitian survey of app integration into counseling patients with hypertension
IRB #: 18028
Approval Date: July 19, 2017

Thank you for submitting the completed IRB application form and related materials. Your application was reviewed by the UIUC Office for the Protection of Research Subjects (OPRS). OPRS has determined that the research activities described in this application meet the criteria for exemption at 45CFR46.101(b)(2). This message serves to supply OPRS approval for your IRB application.

Please contact OPRS if you plan to modify your project (change procedures, populations, consent letters, etc.). Otherwise you may conduct the human subjects research as approved for a period of five years. Exempt protocols will be closed and archived at the time of expiration. Researchers will be required to contact our office if the study will continue beyond five years.

Copies of the attached, date-stamped consent form(s) are to be used when obtaining informed consent.

We appreciate your conscientious adherence to the requirements of human subjects research. If you have any questions about the IRB process, or if you need assistance at any time, please feel free to contact me at OPRS, or visit our website at http://oprs.research.illinois.edu

Sincerely,

Michelle Lore

Michelle Lore
Human Subjects Research Specialist, Office for the Protection of Research Subjects

Attachment(s): Online Consent, Waiver of Documentation

c: Kristen DiFilippo

Office of the Vice Chancellor for Research | Office for the Protection of Research Subjects
University of Illinois | Urbana-Champaign
805 West Pennsylvania Avenue, MC-095 | Urbana, IL 61801
Phone: (217) 333-2670 | Email: irb@illinois.edu
Website: http://oprs.research.illinois.edu

Office for the Protection of Research Subjects

Providing administrative support, services, and resources to the research community and the IRB

"Under the Illinois Freedom of Information Act (FOIA) any written communication to or from University employees regarding University business is a public record and may be subject to public disclosure."